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Roads, Motor Cars and Taxes

We believe it is a shortsighted policy that leads motorists, organized and unorganized, to oppose special taxation for highway purposes. We refer of course, principally to the gasoline tax. It is argued against it that the property tax on motor cars goes into the general fund out of which are paid the public's bills, many of which are of no benefit to the motorist—at least not to the motorist purely as such. It is unfair, therefore, according to this view that after having been made to contribute to the general fund the auto drivers should be singled out as the only class which must pay for the special benefits it receives. Furthermore, our highway improvements are a benefit to the whole community—to everyone served either directly or indirectly by motor vehicles.

Looking at the question broadly what do we find as to the disbursement of moneys paid in property taxes? School taxes are levied against all property as a matter of policy. It is to the interest of the State that its youth be educated, and as great numbers of parents would be wholly unable to pay their pro-rata of a school tax levied on parents only, the tax is assessed against property, whereby the bachelor and the rich pay for educating the children of the poor. Hospitals and asylums are institutions of a civilization which has progressed so far that it can not leave its defectives to their fate. As there is no logical way of assessing these costs, they are paid out of general taxation.

The army is for the protection of all property, and its cost is logically met by property or income taxes. The navy is more vital to the coast than to the interior, and it would be fair enough if the coast were to bear an increased portion of its expense, though obviously no scientific apportionment could be made. War pensions are costs that only the nation as a whole can bear.

Civil protection, including all forms of policing, criminal courts, and penal institutions is primarily for the benefit of property and so should be paid for by property taxes.

Three items—war, civil protection, and education—consume altogether the bulk of taxes collected. Of other expenditures, many, like care of incompetents, which cannot be assessed against the beneficiaries, must be paid in some way by the general population. Certain others undoubtedly could, and should, be assessed to the parties benefited. City fire protection is an example. There would be much justice in assessing the cost of our fire departments to property in accordance with underwriters' schedules. If taxes for such purposes were levied against the beneficiaries wherever practicable, even the semblance of an argument against gasoline tax would disappear.

The one great exception to the practice of defraying public expenditures from general taxes is in the matter of public improvements—particularly streets and roads. Here the assessment is against the abutting, and sometimes other adjacent, property on the theory that this property receives the benefit. As a matter of fact it is impossible to tell just what proportion of benefit actually accrues to any single tract for the construction of a road past it. In some measure the whole community benefits; and there are plenty of instances in which, for one reason or another, the "improvement" actually has damaged the property.

We have, then, this situation—the automobilist's general taxes are expended largely for civil and military protection in which his property shares pro-rata with other property. Above this there are taxes for education and other purposes, which either from necessity or public expediency are levied against the public at large instead of against the beneficiaries. A very minor portion of the general tax to which automobiles contribute a part is for purposes which could and should be financed by taxes directly on the beneficiaries. Special assessments are intended to place the cost of improvements on the beneficiaries, but often fail to do so.

What is there in these conditions which warrants the financing of road construction and maintenance by a special tax on motor vehicle operators rather than by a tax on all property or incomes? This we think is the answer: The fairest conceivable system of taxation would charge each citizen with the cost of the benefits he receives except in a few such cases as education and care of the sick, in which the beneficiaries palpably cannot meet the cost. Civil and military protection, by being met from property and income taxes, are paid approximately in proportion to benefits. Property assessments for public improvements are intended to make the beneficiary pay the costs, though practically they often come very far from so doing. The gasoline tax when expended for road purposes is peculiarly efficient in placing the cost on the beneficiary: in fact, it is doubtful if any other tax approximates it in this regard. The only charge of unfairness which the motorist can logically make, is in regard to the comparatively small group of expenditures which it would be practical to charge to the beneficiaries but which are not so charged. To let this stand in the way is letting the tail wag the dog. Furthermore our tax system is full of admitted imperfections, and there are many people with juster grounds of complaint than the motorist who pays a gasoline tax.

Finally as a matter of individual selfish interest, the motorist should be glad to pay liberally for the roads he needs so badly. The tax of ten per cent, more or less, which he may pay on his gasoline, is an insignificant item in his total motor costs; and certainly should not be allowed to stand as an obstacle to conspicuous benefits. Road improvements and betterments will come quicker and in larger amount if motorists assume this additional cost, than if they insist on the public at large (which still contains a strong element not directly interested in motor welfare) sharing the burden pro-rata on property.

Broad Highways

Editorial in Chicago Tribune

A dozen townships, five counties, two states, and the federal government have combined forces to put through the first through highway contemplated in the regional improvement schedule drawn up for the Chicago transportation zone. The new road, which is in reality the improvement and linking up of existing roads, will connect Kenosha, Wis., with Kankakee, Ill., passing through Chicago via Western avenue and through 32 towns and cities.

To the Chicago Regional Planning association is due the credit for combining all the forces which will make the new highway possible. The vision of the men who foresaw that Chicago and the region about the city must plan together as a unit is vindicated.

The talk of these regional planners sounded grandiose a few years ago, when they contemplated the unified improvement of an area with a radius of 50 miles. Since then they have justified their prophecies. The big figures of yesterday are commonplace now. James T. Voshell, United States highway engineer, declares pavements 44 ft. wide are not wide enough. Not long ago 9 ft. was wide enough; then it grew to 18. Now the planners contemplate a 60 ft. width without gasping.

Such highways, surely, must be built if the Chicago area is to have adequate transportation. The new route, which will provide a direct road between Green Bay on the north and Danville on the south, must be only the first of many more such. The coming spring and summer will see still more passenger cars and trucks on the roads. There has been talk about the automobile saturation point being close at hand. That point is far away still, if the estimated output of 4,200,000 motor vehicles in 1925 is any indication.

The necessity is for roads, through roads, broad roads, well paved, so built as to make speed and safety possible at the same time.

Illuminated Traffic Line

An experimental illuminated "white line" for the guidance of traffic is being tried out at Hendon, England. The frame is of wrought iron, about 3½ in. wide by 5 in. deep; it is formed in three sections and has a total length of about 30 ft. The top of the line forms a kind of frame in which pieces of laminated white marble and prism glass are placed alternately. A number of 220-volt, 40-watt Osram tubular lamps are fitted at the bottom of the frame which, when illuminated, produce the white line, visible to motorists at a distance of 200 yds. Results of tests have shown that the light is not decreased in intensity by motor head lights or street lamps.

Thinking is a Kind of Memory

By HALBERT P. GILLETTE, *Editor*

That all thinking depends upon memory will be evident to anyone who will carefully examine his own thinking processes. It is much less obvious that all thinking is purely a memory process invariably associated with certain muscular contractions.

When you hear the well known voice of a friend, B, even though you do not see the speaker, you infer the presence of that friend; and you may "infer" all his characteristics, physical and mental. To yourself you say in effect: "Here is B." And if someone were to ask you the color of his hair, you could safely reply: "Black," if black had been its color when you saw him a short time ago. Yet this answer would be an inference, and the inference would be purely a matter of memory.

Similarly if you hear the well known caw of an unseen crow, you infer the presence of a crow and you may infer any of a crow's characteristics, such as blackness of plumage. But in making such a deduction, you are performing merely an act of memory, precisely like the act of remembering the color of your friend's hair.

We are accustomed to speak of some kinds of remembering as acts of memory, whereas, we call some other kinds deductions, but the distinctions between the two kinds are relatively slight. When, from some characteristic, we infer the presence of a member of a class of things, and then infer any one or more of the characteristics of that class, the process is called deductive reasoning. But when we infer the presence of an individual and then are able to name one or more of his individual characteristics, the process is called remembering. Yet the difference in the two mental processes is superficial, the one being a remembering of class characteristics, the other a remembering of individual characteristics. Even this distinction vanishes when the individual, B, is remembered as being a member of a class (e.g. man) and when one of the characteristics of that class (e. g. possessed of a backbone) is remembered.

It is true that we often infer characteristics that we may not have perceived as being attributes of a given class. How, then, can our inference be a memory? Can a person remember what he never has perceived? Thus, I read that gold is very malleable, but having never seen anyone hammer gold into a thin leaf, how can I be said to remember the malleability of gold? The answer is that I accept as true the experience and therefore the memory of some one else as to the malleability of gold. But even then, if the word malleability has any meaning to me, I must have perceived the malleability of something, such as iron. My memory of malleability, then, must be invoked by my informer when he tells me that gold is malleable. Otherwise the generalization "gold is malleable" is meaningless to me.

When I accept the experience of someone else, as conveyed to me in words or other symbols, I form a "mental picture" in which I bring together things or attributes that I have already experienced. This mental picture then becomes as truly a part of my experience as if I myself had brought its elements into association instead of being indebted to someone else for having led me to form the association.

Where no meaning is attached to a word, as when a parrot utters a sentence no word of which it comprehends, we have memory, it is true, but not the sort of memory that is commonly called thinking. Yet even in such a case there is a process of thought. The words "Polly wants a cracker" uttered by the parrot may arouse in the parrot no image of a disc of baked dough, but it may arouse visions of a meal or of its master's presence, or of anyone or more of the things that it has learned to associate with those words; and to that extent the parrot thinks when it remembers that sentence, which as a whole has some meaning to the parrot, although each of its words by itself may be meaningless.

In general, a symbol that has been "learned" always arouses some memory, although the memory is probably never identical in any two individuals. One of the objects of logic is to teach the desirability of using words so as to arouse mental images that are so nearly alike in all persons as to lead to no misunderstanding. Hence the great importance of the chapters on logical definitions.

Perhaps the two greatest obstacles to be overcome before thinking can be regarded as being remembering are: First, the paradox of remembering "inconceivably" great or small things. Second, the paradox of orginating anything by remembering. Yet both paradoxes are explainable.

The first paradox arises from failure to understand the nature of a conception. To conceive commonly means to form a mental picture, and, almost invariably, the picture is supposed to be formed instantly, being, in short, a stationary or static picture. Sight is lost of the fact that many of our conceptions are

moving pictures, corresponding to experiences. You may picture a dog in a flash, but it takes time, and lots of it, to picture a trip to Europe. Similarly, you can picture in a flash a small number, say 10 (as 10 fingers), but it takes time, and lots of it, to picture the distance in miles to the sun. Anyone who fully understands (i.e. pictures) the process of multiplication as being a process of successive additions can picture a million as a series of additions of tens, each of which he can picture in a flash, but which taken as a whole can be pictured only as a series—a moving picture. It is, therefore, false to speak of a million as being inconceivably great. In fact a hundred can not be pictured at a glance, and is just as inconceivable as a million, if you use the term conception to mean instant picturing. In the final analysis no conception is instantaneous. Even a group of 10 takes time to conceive, but the time, being so very brief, is ignored, thus leading to a false conception of conception.

The common definitions of point, line and surface are false; since all have three dimensions, albeit at least of the dimensions is so very small as to be "infinitesimal." We get correct answers in geometry in spite of those false definitions, because we always ignore that part of the definition that assigns a nil dimension. The space assigned to this article is to brief to discuss further this phase of the nature of conception, further than to say that infinitesimals, like infinites, are conceivable if we do not try to conceive them at one stroke, instaneously.

Does an inventor invent by remembering? He does. If you have originated anything and can recall your steps, you will see that the idea of the new thing was first suggested by some analogy. An analogy is a likeness often remote, and it can be perceived only by virtue of remembering. So at least we must start an invention by remembering. We build a new mental picture out of parts of old mental pictures. The elements are all old, but the combination of the elements may be novel. Yet even the new combination is suggested by something that it resembles. Thus Edison invented a phonograph, not a single element of which was novel; and even the combination was suggested by existing instruments for recording vibrations. Sound is itself a vibration, and, by analogy, might be recorded. But if recorded in such a manner as to recreate the vibrations by reversing the process, a phonograph would result. Machines that reversed processes already existed. So, there was not a single new step in the entire process of conceiving a phonograph.

Invention, and indeed every form of originality, is purely relative. In every case its every step is guided by analogy. Only where some unexpected result is suddenly come upon, does analogy cease to be the guide.

If originality is primarily an expression of memory, the practical importance of regarding thinking as a memory process becomes apparent. At once we gain great respect for memorizing, not the parrot-like memory of meaningless symbols, but the memorizing of facts that may be used in solving economic and other problems.

Road and Street Contracts Awarded During the Last 73 Months

The accompanying table, compiled from statistics in the Engineering News Record, shows three outstanding facts: First, that highway contracts awarded during the last half of each year have averaged only 25 per cent less in volume than those awarded during the first half; second, that there is not a month in the year without a very large volume of road and street contracts awarded; third, that each year shows a substantial gain over its predecessor.

ROAD AND STREET CONTRACTS EXCEEDING $25,000 IN SIZE

	1920	1921	1922	1923	1924	1925	1926
January	$ 12,204,000	$ 11,598,000	$ 14,424,000	$ 21,691,000	$ 16,972,000	$ 22,720,000	$ 19,989,000
February	21,334,000	12,049,000	9,052,000	18,781,000	19,214,000	20,104,000	.....
March	26,221,000	25,880,000	39,669,000	37,706,000	41,395,000	25,910,000	.....
April	33,340,000	31,026,000	32,991,000	29,641,000	43,513,000	60,801,000	.....
May	30,258,000	35,064,000	42,284,000	46,528,000	65,354,000	53,418,000	.....
June	31,441,000	56,777,000	42,138,000	38,040,000	44,494,000	42,451,000	.....
July	29,353,000	33,943,000	26,087,000	42,397,000	45,784,000	45,246,000	.....
August	18,565,000	28,693,000	37,035,000	35,639,000	40,536,000	41,199,000	.....
September	26,537,000	23,257,000	28,884,000	37,812,000	44,585,000	36,949,000	.....
October	12,894,000	20,055,000	23,162,000	28,144,000	35,198,000	31,416,000	.....
November	12,443,000	20,751,000	20,892,000	23,683,000	18,382,000	23,492,000	.....
December	10,834,000	16,263,000	18,096,000	21,035,000	14,894,000	19,635,000	.....
Total	$265,424,000	$315,356,000	$334,741,000	$381,097,000	$430,231,000	$423,341,000	.....

Note.—About 100 per cent must be added to these totals to give the grand total of highway contracts in the United States.

Bridges are not included, and bridge contracts average 15 per cent as much in value as road and street contracts. A great deal of road and street work is done by directly hired labor and is not included above.

Joints in Concrete Pavement

Method of Securing 100 Per Cent Joint Employed on a Federal Aid Job in Arizona

By W. W. LANE
Chief Engineer, Arizona Highway Department

I was very greatly interested in an article appearing in Roads and Streets of Jan. 6, 1926, page 63, entitled "How to Get Good Joints," by H. Eltinge Breed, consulting highway engineer, New York City.

Mr. Breed very properly stressed the point that "Finishing is a most important factor, for a smooth pavement has to resist only a moving load, while a pavement which is uneven has to endure also the highly destructive force of impact," and "that proper finishing includes cutting through and rounding all joint spaces." Mr. Breed further stressed the point that concrete by its very nature does require expansion provision.

The article is very clearly illustrated by Figs. 1, 2, 3 and 4, and is a sad reminder to many experienced in concrete highway construction. While Mr. Breed illustrates the many possible, and unfortunately the all too frequently occurring, joint defects, he does not offer a solution of them, except in the use of dowels in joints, which in that case solves the question. The many other and even more serious defects are left to the all too lax inspection, and many of the defects, or those occurring at the bottom of the joint, and extremely serious ones, are not possible to inspect when the pre-moulded joint fillers are used as it has been used in the past. The only possible method of obtaining the ideal joint by inspection alone, as shown in the bottom cut (Fig. 2) of Mr. Breed's article, would be to construct open joints and make a thorough inspection before pouring the filler.

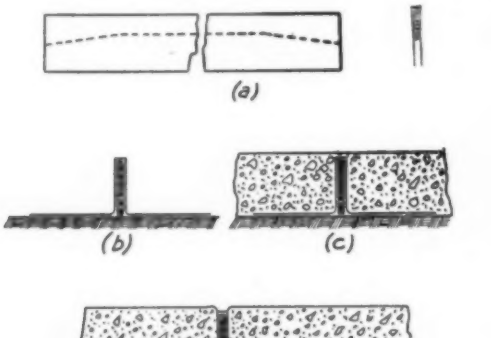
The almost universal adoption of the thickened edge section for concrete pavements adds materially to the probability of the pre-moulded joints not extending to a positive contact with the subgrade, thereby letting wedges of the concrete be forced under the joint filler to later act as wedges to lift the abutting slab, as it is practically impossible to finish the subgrade for this pavement section to the theoretical section and yet the pre-moulded joint filler is cut to the theoretical section.

Arizona has recently completed a section of concrete pavement of the thickened edge type nine miles in length—Federal Aid Project, No. 71, under Mr. Geo. B. Shaffer, district engineer. To obtain the maximum smoothness and to prevent any difference in elevations of the two abutting slabs at the joint, a submerged joint coming to within ½ in. of the surface was adopted to permit uninterrupted operation of the mechanical finishing machine and longitudinal floats. This immediately required elimination methods for every possible defect shown in Figs. 2 and 3 of Mr. Breed's article. To overcome these, and in the absence of a satisfactory pre-moulded joint on the market for obtaining the desired results, we purchased the pre-moulded joint fillers, cut to the desired template, and placed over the fillers, just before installation, a strip of burlap the length of the filler, and of sufficient width to go over the filler and in addition found a skirt on either side of some 8 to 10 in. in length. This was then installed ½ in. below the surface; one skirt was laid flat on the subgrade so as to come under one slab and the skirt on the other side of the filler laid flat on the subgrade so as to be under the other slab; otherwise the joint was placed in the usual method of installing a joint filler (see Fig. 1). The finishing of the pavement continued over the joint as any other part of the slab. Just before the final belting, the ½ in. of material above the joint was removed for the full width of the joint by the use of a ½ in. edging tool and trowel. This leaves a positive joint at the top with ½ in. bevels on the slabs, and the burlap insures a positive joint at the bottom. The line of the joint for its full thickness is very readily seen in the green concrete for edging and removing the concrete from over the top of the joint.

While the use of the burlap or skirt was primarily used for preventing the concrete from getting under the joint and forming wedges, it was found to be extremely advantageous in all other respects. The weight of the concrete on the skirts made a positive anchor to prevent the joint from working up and apparently greatly assisted in maintaining a perpendicular joint. Many cores have been taken through these joints with a core drill, showing 100 percent

full joints and only an occasional and very slight variation from perpendicular. The smoothness and riding qualities of these joints and the clean-cut and neat appearance are a revelation.

In November the writer visited a section of the Super-Highway just out of Detroit, which is a wonderful accomplishment in modern highway construction, but the contrast in the joint



(a) Plan and section of premoulded joint with burlap strip folded over
(b) Joint in place on subgrade ready to receive concrete
(c) Concrete in place and finished over joint
(d) Finished joint showing rounded edges

Fig. 1

construction, to the installation described above, was a great disappointment in both riding qualities and appearance. In addition to the smoothness of the pavement above described at the joints, the joints are known to be 100 percent joints and as recommended by Mr. Breed in the bottom cut of Figure 2 of his article, while those installed in the Super-Highway out of Detroit are only hoped to be, as inspection at the bottom of that type joint is impossible after the placing of the concrete and the completion of the finishing operation.

Marking Interstate Highways.—Interstate highways in the future will possess both an identification number and a local distinctive name, according to a resolution presented and passed in the business session of the recent convention of the American Road Builders Association. In this manner highways extending across the United States will have a national number for tourist's convenience, and will be locally identified by a name that would be inconvenient for national use.

State Aid for Urban Highways

In 1926 the state of Wisconsin will pay a total of $1,865,218 to the towns, cities and villages for work on 62,743 miles of roads and streets eligible to receive state aid under the provisions of the new highway law. The Highway Commission determined the various allotments on the basis of the mileage of highways in each unit of government entitled to receive aid from the state highway funds. The summarized allotment, according to the reports filed with the Highway Commission is given in Badger Highways as follows:

Public roads in towns eligible to receive $25 per mile, 56,914 miles, $1,422,854. Public streets in villages eligible to receive $25 per mile, 1,501 miles, $37,540. City streets eligible to receive $200 per mile, 548.5 miles, $109,700 (this is the city of Milwaukee only); $150 per mile, 400 miles, $60,000; $100 per mile, 1,322 miles, $132,176; $50 per mile, 2,057 miles, $102,850.

These allotments under the provisions of the new highway of law of Wisconsin constitute a radical departure in the distribution of motor vehicle revenues, and it can be safely stated that no other state in the Union has adopted a plan along these lines. The idea, under the provisions of the new law, was to give a sufficient sum to the town roads to pay the cost of dragging them, or putting them in such condition as to permit the rural motor vehicle owners to reach the state or county trunk highways with a reasonable amount of comfort and safety; and also to assist the villages and cities, in a small way at least, in the maintenance of their streets other than those that are a part of the state trunk highway system. For the latter, the villages and cities receive the same amount per mile as the adjoining state trunk highways in the county receive, the primary federal aid roads getting $500 per mile, the secondary federal aid roads $400, and the ordinary state trunk highways $300 a mile.

The allotments to the towns and villages are paid by the state treasurer to the county treasurer of each county immediately after the first of the year, and the county treasurers then pay for work done by the towns in accordance with whatever plans the county highway committees and the town boards see fit to adopt. The allotments to the cities are paid directly to the city treasurers.

New Jersey Cities Want Share of Gas Tax.—The New Jersey State League of Municipalities at its 11th annual convention on Feb. 4 adopted a resolution approving a plan whereby municipalities would share in the receipts from the gasoline tax.

Accidents on State Highways

Statistics for Indiana Given in Paper Presented at Annual Road School Purdue University

By A. H. HINKLE
Superintendent of Maintenance, Indiana State Highway Commission.

The Maintenance Division attempts to make a report on a blank form for this purpose, of all accidents occurring on the state highway system. These accidents are reported for statistical purposes with a view of learning, so far as possible, the cause of accidents. It is hoped that every means possible may be used to reduce them. The following table shows as nearly as our field forces can secure the information, the data concerning these accidents. We do not permit these accident reports to be used in damage suits. We believe that our men would hesitate to furnish their best opinion of the cause of accidents if they knew their statement would be subject to public inspection and possible legal action against them if they were not able to prove their statement.

The following is a summary of the accident reports for the past five years:

COLLISIONS

Mch. 1, '22 to Sept. 30,'22	Oct. 1, '22 to Sept.30,'22	Oct. 1, '23 to Sept.30,'24	Oct. 1, '24 to Sept.30,'25	
157	332	370	654	Total No. accidents reported.
49	109	160	302	Colsn with other machines
4	16	6	19	Colsn with RR trains (steam)
5	14	15	17	Colsn with guard rails
1	0	0	1	Colsn with bicycles
7	9	11	14	Colsn with culvert headwalls
7	21	12	33	Colsn with telephone poles
2	11	6	7	Colsn with wagons.
1	6	5	11	Colsn with electric cars
8	12	12	21	Colsn with fences
2	7	8	5	Colsn with animals
5	20	30	40	Colsn with bridges
20	48	14	22	Colsn with miscl. objects

CAUSES OF ACCIDENTS

99	140	181	335	Fast driving
8	14	21	28	Steep grade
41	51	33	78	Sharp curve
8	26	21	22	Lack of guard rail
3	13	16	28	Wet surface
5	15	13	27	Deep ditch
23	25	40	66	Intoxication
9	17	25	54	Glaring headlights
29	59	41	45	Narrow roadway
9	29	24	47	Obstructed view
25	37	14	37	Miscellaneous causes

DEATHS and INJURIES from these accidents were reported as follows:

157	332	370	654	Accidents reported
30	38	50	103	Deaths
133	196	255	529	Injuries

Every effort is being made by the Highway Commission to eliminate from the state highways those physical conditions which contribute to accidents. This past year, the Maintenance Division alone has eliminated 12 grade crossings with railroads, by relocating the highway. The importance of eliminating these crossings on our heavily traveled roads is demonstrated when we learn, that of the 103 accidental deaths on the state highways this last year, 37 deaths, or over one third, were caused by accidents at grade crossings.

Frequently it is found that a grade crossing can be eliminated by relocating the highway for a much less expense than building a subway or an overhead. Many times the only opposition to such elimination comes from the few residents who live along the old location. It is desired that every county official will use his moral influence, although his county may not be able to help financially, in bringing about the elimination of grade crossings. **Certainly no road official should be guilty of lending aid to the perpetuation of this form of murder, for such it might be called when the crossing can be eliminated at a nominal expense.**

Financing Urban Highways

Information on State and County Grants and Other Forms of Aid to Cities Given in January Public Roads

By JACOB VINER
Professor of Political Economy, University of Chicago

In a number of states grants are made by the state out of its highway funds to the cities for use in financing city streets. The treatment in this respect of large cities is often different from that accorded to small towns, and we will deal first with the cases in which cities over 30,000 in population receive state aid for street purposes from the state, either immediately or intermediately through the counties, and either in the form of appropriated grants or by permitting the cities to share in the motor vehicle tax revenues. Most of these instances are of very recent origin and are the result of pressure from the cities for a share in the motor-vehicle tax revenues, but some of them are of long standing.

State and County Grants to Cities.—While the list which follows may not be quite complete, it is believed to include all of the more important instances.

Alabama: 20 per cent of the net receipts from State motor-vehicle licenses collected within municipal limits is returned to the municipality where collected.

California: 50 per cent of the receipts from State motor-vehicle and gasoline taxes is returned to the counties. The city of San Francisco, which is also the county of San Francisco, and apparently also the city of Los Angeles, through the county of Los Angeles, share in the State motor-vehicle revenues through the apportionment to the counties.

Colorado: 50 per cent of the motor vehicle license fees and the gasoline tax receipts collected within each county

is returned to the county. Denver city and Denver County are coterminous, and Denver city therefore receives 50 per cent of the State motor-vehicle tax revenues collected within its limits.

Maryland: The city of Baltimore, which is a separate unit in the organization of the State, receives from the State 20 per cent of the State motor-vehicle revenues.

New York: New York City, as a unit in the county organization of the State, receives 25 per cent of the State Motor vehicle registration fees collected within its limits.

Ohio: Cities receive 50 per cent of the State motor-vehicle license fees collected within their limits and 30 per cent of the gasoline tax receipts.

Oklahoma: 90 per cent of the State motor license fee receipts is returned to the county where collected, and 25 per cent of the county's share is returned to the cities and towns within the county.

Pennsylvania: Philadelphia, which is coterminous with Philadelphia County, received in 1925 a grant of $250,000 from the State motor license fee receipts.

Wisconsin: The State makes grants to cities out of its highway fund as follows: (a) City streets connecting portions of the State highway system, $300 to $500 per mile, depending upon the classification of the streets; (b) other city streets, cities with population over 10,000, $100 to $200 per mile of street, the amount per mile increasing with the population.

Other Forms of Aid to Cities.—In a few instances state aid is given to large cities for highway purposes in other ways than by grants or by refunds of a fraction of the motor vehicle tax receipts. In Alabama, Iowa, and Kansas the state shares in the cost of construction of highways within city limits which connect the street system with the state highway system. In Washington the state pays the cost of maintenance of state highways within city limits. In other states, as, for instance, California for one state route passing through Los Angeles, and Louisiana for two state routes passing through New Orleans, the state in exceptional cases contributes to the cost of specified state routes passing through or on the outskirts of large cities. As a general rule, subject only to occasional exceptions under special circumstances, all other states require the larger cities and towns to finance from their own municipal funds the pavements which are connecting links in the state highway systems.

In general, also, the counties make no contribution out of county tax revenues to the financing of the streets of large cities, though the situation is complicated in a number of instances by the merging of the county with the municipal governmental organization. Three exceptions to this general rule have been found, however. In Arkansas and Florida the counties turn over to the cities within their limits for street use part of the proceeds of the county road taxes. In the state of Washington 50 per cent of the cost of arterial streets in excess of assessments against neighboring property is borne by the counties or the districts with which such streets connect. Nebraska presents an exceptional instance of the reverse character. Not only do the state and the counties make no contribution to the financing of the streets of the larger towns, but the cities of Omaha and Lincoln are required to contribute out of city funds 50 per cent of the cost of construction of outlet highways outside their limits but adjacent thereto.

These various grants from state and county funds in aid of urban highway finance follow no uniform rule, and there is no evidence which indicates that the basis of apportionment of the state and county funds between urban and rural purposes has in any instance been determined by consideration of the respective ratios of urban and rural use of the highways and urban and rural contributions through taxation to their support. In a number of the instances cited cities share in the state motor vehicle tax revenues only because of the accidental fact that the municipal and county organizations have been merged or are coterminous. These grants are not very important even in the aggregate, an examination of the detailed evidence indicating that they did not exceed $20,000,000 in 1923 for all cities in the United States having a population of 30,000 or over.

Aid for Small Towns.—Small towns, and especially those under 2,500 in population, receive more generous treatment. It is the general rule or the frequent practice in a majority of the states for the state itself to construct or to provide funds for the construction of standard sections of state highways passing through towns not exceeding a specified population; in some cases maintenance also is provided by the state. This is a desirable practice, if for no other reason than to provide a safeguard against serious impairment of the efficiency of state highway systems through the persistence of unpaved or unsatisfactorily maintained sections within the limits of small towns. In a few states, especially in New England, small towns receive aid from the state in financing their general street program, whereas larger cities receive no such aid. This may perhaps be justified on the ground that for very small towns the town limits are not to any appreciable extent traffic boundaries, and common financing with the surrounding rural highways is logical. In states in which the county is an important political unit it would be more desirable that any aid given to small towns for their general street program should be given by the county rather than by the state. Such streets, like local rural roads, render little service to the dwellers in large cities, and they should not be made, through their contributions to the state tax revenues, to contribute to their support.

Motor Vehicle Registration in 1925.—According to the annual statistical review of the Goodrich Tire & Rubber Co., 20,229,025 motor vehicles were registered in 1925. This was an increase of 13 per cent over 1924.

Highway Transport Surveys

Benefits and Uses of Data Derived from Them Outlined in Paper Presented January 16 at Conference of Mississippi Valley State Highway Departments

By HARRY J. KIRK
State Highway Engineer of Ohio

A highway transport survey is a measurement and study of highway usage in order to make the road dollar go farther.

It is an effort to learn what return is being made on the investment of public highway funds and to secure better returns in the future. No corporation organized for profit would long continue a scheme of expansion of plant and equipment without regard to the future use or present need for that increased machinery. We have not had up to the present, and there is no immediate prospect of having public funds in adequate amount to keep pace with the increased use of our highways by the millions of motor vehicles. It, therefore, behooves highway officials to so study the expenditure of the highway dollar that it will bring the greatest return possible in transportation service.

Great study has been given to the technique of building good pavements. And great progress has been made. We know, if we are given money enough, how to build a smooth and lasting pavement. It is time we gave more thought to the use of these pavements for transportation service. Obviously we can not afford to build a $50,000 a mile pavement where only a hundred or two people will use it in a day, when in other places a thousand vehicles a day wallow through miles of mud or struggle slowly over narrow or inadequate pavements. Yet these things have been done and are being done now in many places.

Nature of a Transport Survey.—The writer has studied transportation surveys made in cooperation with the U. S. Bureau of Public Roads in Maine, California, Connecticut, Pennsylvania, Cook County, Illinois, and particularly in my own State—Ohio.

Weighing Trucks at Rocky River, State Route No. 2, West of Cleveland, O.

The nature of these transport surveys is best understood by knowing the nature of the data obtained, which in Ohio were as follows:

(a) The number and type of vehicles.

(b) The rated capacity and gross, axle and wheel loads of motor trucks.

(c) Principal commodities transported by motor truck.

(d) Towns of origin and destination of passenger cars and motor trucks.

(e) Type of usage of passenger cars.

(f) The number of out-of-state vehicles.

In Ohio there were 354 regular traffic survey stations, 156 stations where trucks were weighed and 1,000 stations where several density counts were made.

The survey started Dec. 15, 1924 and was concluded Dec. 15, 1925. The cost was $75,000 to the State of Ohio and an equal amount to the Bureau of Public Roads. The results are now being prepared for publication in Washington.

Important Facts Learned.—The most striking facts brought out by highway transport surveys is that highway traffic is chiefly local traffic. This is particularly true of truck traffic. Connell of Pennsylvania says the survey in his state showed that 92 per cent of the highway traffic is local and only 8 per cent through traffic. Thos. H. MacDonald, Chief, U. S. Bureau of Public Roads says:

Weighing Construction Truck and Trailer on State Route No. 3

"The results of the Connecticut Transportation Survey indicate that 55.7 per cent of all passenger cars have an average trip mileage of less than 20 miles, and 72.0 per cent less than 40 miles. In the same state it was found that 81.1 per cent of the motor trucks traveled less than 30 miles per trip. In Cook County, Illinois, the corresponding percentage was 75.8 per cent.

Density of population is an index of traffic volume. The more people in a given area the more automobiles and trucks serving that area and the more traffic.

We have been accustomed to think of certain highly advertised routes as great arteries congested with heavy traffic at all points. This is far from the truth.

There are no great interstate routes of heavy traffic except where the route passes through a thickly populated section, and the traffic is then a series of heavy local movements and the amount of through traffic is quite small. Hence it is that traffic mounts rapidly near thickly populated centers necessitating wider pavements and more ways of ingress and egress. On the contrary traffic dwindles rapidly as we move away from the city and so-called super-highways, even on such sections of main routes are a waste of public funds.

One station on the Cook County survey at the Chicago city limits showed over 15,000 vehicles per day while on the same route, only nine miles out of the count showed less than 4,500 vehicles in the same period. Truck traffic at the same locations decreased from 543 to 238 trucks.

Estimating Future Traffic.—The best way to judge the future is by the past. So it is in estimating future traffic. A knowledge of traffic for a period of years in the future is necessary for an economic highway program.

Knowing the factors determining the nature and volume of traffic in the past, such as population density, industrial developments, etc., it is possible to predict with great accuracy traffic in the future.

In Maine, for example, they have found over a 10-year period that the rates of increase of traffic and registration are approximately the same. They estimate that between the date of their survey, 1924 and 1930 that traffic will double.

Classification of Highways.—The widest application of the data obtained in a transport survey is in the scientific classification of highways.

The proper width of pavement may be figured for each particular section of a route. This width will vary widely on the same route. Volume of traffic, particularly the number and frequency of heavy axle loads, together with the legal weight restrictions will help in fitting each road section with its proper design, thus providing a classification of road sections as to design.

A classification may be made at the same time in reference to ultimate width of right-of-way. Pennsylvania has started a program

to acquire the right-of-way needed now and save the cost of damages that might have to be paid in the future. Witness the enormous amounts cities are spending widening narrow streets and you can realize the wisdom of this policy.

Many states, particularly in the east, are facing a big reconstruction and widening problem. Surely volume of traffic is the most important factor in outlining a reconstruction program. It might be well to explain here that it has been found to be the general rule that where the volume of autos is heavy the volume of trucks is correspondingly heavy and vice versa.

The day is drawing near when we will have a classification of highways as to loads permitted thereon. Such a classification will not be possible without transportation survey information. It will be found advisable on sections near cities to permit heavier loads than on outlying highways.

In cities we find ordinances in effect prohibiting horse drawn vehicles on certain thoroughfares. Trucks are prohibited on boulevards and certain main streets. There is bound to develop a classification of rural highways as to traffic regulation, load and speed limits more detailed than enforced at present.

Relationship Between Volume of Traffic and Maintenance Costs.—I have often been impressed with the lack of accurate costs on highwas maintenance and repair. We have been keeping cost records by road sections in Ohio for 12 years, but changed conditions have changed our system and the personal element on the original cost distribution has had a marked effect on final averages. Maintenance costs per mile don't mean very much for comparative purposes. Even maintenance costs on a square yard basis are inadequate. We must know something of traffic volume during the period covered by the records. Transportation survey data may be used to show the relationship between volume of traffic and maintenance costs.

A Highway Program and Budget.—The economic expenditure of highway revenues seldom, if ever, adequate to meet traffic demands, necessitates the handling of the most important projects first. Road money in the past and in the present and no doubt in the future also will many times be placed on account of "Pull" and regardless of traffic needs. The truth brought out by transportation surveys given wide publicity will enable the establishment of a highway program and budget, placing the projects for improvement in their order of importance.

Weighing Truck Hauling Mixed Freight Between Springfield and Dayton, O.

Highway Legislation. — How often when highway legislation is being framed have we not felt the need of the data supplied by a transportation survey?

No better material can be employed in support or measures to finance highway budgets. Suppose the State Legislature is considering a gas tax. One argument is the volume of foreign car traffic using the state's roads free of charge. With accurate information on this subject available much can be accomplished. In matters pertaining to traffic regulation, policing, railroad grade elimination legislation, there is no end to the utilization which can be made in framing road laws.

Miscellaneous Benefits.—There are many minor utilizations of highway transportation data. For example, it is valuable in framing

a snow removal program. What highway administrator has not been stormed many times by a delegation from some back section of the state obsessed with the idea that their own particular route is the most important in the counry. They paint in glowing terms a picture of double lines of autos and caravans of trucks that use their route. They are generally sincere, although very deficient when it comes to knowing the truth about traffic. Sargent of Maine says his highway transportation survey data has enabled him to stop all arguments and make those present agree that the most important routes should be handled first.

But public officials are not the only ones who use this data. We have had constant calls from bus companies, real estate firms, super-power corporations, oil companies, prospective hotel operators, toll bridge companies and railroad companies in reference to crossings.

I am a great believer in plenty of publicity on highway matters. We depend on public opinion for our support of an adequate highway program. The data available from a transportation survey can be used for an endless amount of publicity that can be given a touch of local news interest and will be read with attention. Based on solid truth such publicity can be so framed as to be of wonderful benefit in getting popular support to an adequate highway program.

Conclusion.—I have outlined some of the benefits and uses which may be derived from the data of a transportation survey.

The survey in itself is of little benefit. It must be applied to the problems of the state it covers. No record is worth keeping unless it brings a return on what it cost. Highway transportation surveys can be made of great benefit or of little benefi. It all depends upon the calibre of the highway administrators.

Transport Survey Party Weighing Load of Cattle on State Route No. 18

Analysis of Highway Railroad Crossing Accidents

In a paper presented Jan. 20 at 12th annual Road School at Purdue University, Chas. E. Hill, General Safety Agent, New York Central Lines, gave the following analysis of accident at grade crossings:

"We find 70 per cent of our crossing accidents occur in daylight, 63 per cent at crossings where there is no obstruction to view and a large majority at crossings with which the driver is familiar—in the counry where he resides—which clearly indicates that he is so familiar with the situation he feels he is immune to danger and drives heedlessly on the tracks without using any care whatsoever; or he sees the train approaching and increases his speed in an effort to beat it over the crossing. It is, also, of interest to know that one out of every five crossing accidents results from the automobile running into the side of the train. Some drivers failing to beat the train over the crossing attempt to 'butt' them off the track."

How to Stop Overrun of Concrete Material

Suggestions for Preventing Use of Excess Quantities of Cement and Aggregate Given in Paper Presented January 13 Before the American Road Builders Association

By ROBERT E. O'CONNOR
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We are all interested in the underrun of cement as well as the overrun; and furthermore the quantity of cement used on a job is so closely dependent on the aggregate and the construction practices that we must direct our attention to the latter rather than to the discussion of cement as a material.

We have overstressed the use of the word cement in connection with overrun and underrun. The use of the word has been so general that it has clouded the issue. Most contractors and engineers have lost sight of the fact, or have not realized, that simply because they are controlling the variation in cement safely between certain limits as set out in a specification, does not mean the stopping of losses in other materials used; and that usually through a lack of knowledge, or a too earnest effort toward the controlling of the cement content by the inspector or contractors organization during construction, the result is a loss through excessive or insufficient use of aggregate, both in quality and quantity of concrete produced.

Contractors have not been awake to the importance, to them, of the subject of overrun and underrun of materials in concrete. Continued losses, however, should cause us to open our eyes and endeavor to help relieve the situation. Those who have investigated the conditions and causes underlying the proposition have come to the realization that it is practically impossible to prevent overrun and underrun of aggregates, including cement, working under the conditions and requirements of the average specification as written today.

Theoretical and Actual Quantities.—In figuring overrun and underrun of materials the theoretical quantity of each kind necessary must govern. It is the exception to the rule when any allowance is made in specifications to take care of losses, except in some cases a variation in cement. Contractors are prone to leave out of their estimate of quantities and provisions for additional materials, over and above the theoretical amount, in spite of a positive knowledge that an extra allowance is necessary to prevent a loss in construction.

While this is true, from the viewpoint of the contractor who has benefited by his experience in construction, there are two bases on which to figure overrun or underrun in a job: The theoretical quantity from the engineer's side, and that of actual practice from the contractor's side.

What may be overrun to the engineer might be a figured loss by the contractor. A peculiar situation arises, particularly on jobs where cement is furnished by the contractor, and where the attention is directed more to prevent underrun without considering overrun of cement.

Much could be said about who is responsible for the conditions that exist and under which we work; but a great part of it is clearly the fault of the contractor. We can help our case by obtaining the information necessary to prove it. We should do so at once and strive to correct it; for what will tend to straighten out our trouble, will, at the same time, result in a saving of materials, cement included, at no loss in quality of product, and establish a real and actual basis of figuring overrun and underrun.

For discussion we will divide the factors entering into overrun and underrun of materials, cement included, under two main headings:

First, the specifications.

Second, the methods and equipment used in construction. These two divisions are practically of equal importance, and inseparable Faults in either one will destroy to a greater or less degree the results desired, in proportion to the seriousness of the fault.

The Specifications.—However, since specifications are written before construction, they are given first place. Contractors, at best, are more or less agents of the engineer in carrying out his ideas as set forth. Therefore, it is well to state at this time that prevention of overrun or underrun of materials, instead of being helped out by the average specification,

is almost guaranteed to occur by their requirements.

In fact a contractor is trying to do an impossible thing when he contracts to meet a rigid specification for neat depth and quality, and, at the same time, confine himself to a definite material content, cement included. This cannot be accomplished in a practical way if the specifications which regulate the mix and methods of construction are to be complied with.

In this connection, it is evidence of an uncertainty or lack of definiteness when we find that highway specifications, which allow practically no variation in finished thickness of slab, do permit a variation from the stated coment factor ranging from 2 to 7½ per cent, and no allowance for increased yardage of sand and coarse aggregate.

This indicates clearly that there is need for a definite and equitable basis for estimating the correct quantities of materials for the job.

Engineers, in their specifications, should recognize the necessity and importance of safeguarding the contractor against overrun of materials as zealously as they guard against underruns, not by consent to laxity of skill or method by the contractor, but by removal of the uncertainties from their requirements.

Uncertainties Regarding Requirements.—For example, when a specification sets out a 1:2:3½ mix, just what do they mean? Do they mean 2 cu. ft. of wet sand or do they mean 2 cu. ft. of dry sand? Does 3½ cu. ft. mean 3½ cu. ft. of coarse aggregate with 30 per cent voids or 3½ cu. ft. with 50 per cent voids? When it is stated that each cu. yd. of concrete in place shall contain 1.7 bbl. of cement, what limit is there placed on the adding or deducting of fine or coarse aggregate to maintain it?

Take the design of the section of slab using the thickened edge, why have the changes in thickness been made so sharply making it impossible to cut and maintain in actual practice. A gradual change in depth in the nature of a curve would make a workable design and give the same results, the only difference being that the extra concrete necessary would be taken into consideration when the end area is figured and provided for, and not lost in construction by the contractor, and considered as overrun.

When a deduction is made from the contract price, for variation in depth of slab below that specified, why isn't additional payment made for increased depth within certain limits, or quantities added to care for it? Why not include an item in the proposal to cover overrun and underrun of pavement depth; payment on same to be made in accordance with clauses safeguarding the state against carelessness of the contractor in construction, but safeguarding him where variations occure in spite of his honest efforts to prevent them?

Where such uncertainties and conditions exist, and a contractor is not permitted to save himself by applying safe and certain safeguards entailing no loss in quality of concrete produced, he is due for a loss in materials over and above the amount theoretically necessary for the concrete to be placed, even though the cement factor is not exceeded.

In connection with the divisions as made, a supplement might be added dealing with the factor of cooperation and understanding between the parties most interested in the subject, the engineer and the contractor. Both should recognize the position and desires of the other and strive to wipe out doubt and uncertainties causing the trouble. This, with an understanding as to the results sought and an honest effort in carrying out the construction, will do wonders in stopping overrun and underrun of materials.

Items that Effect Quantities of Material.—Assuming that the specifications have been established. from the time that shipment of cement and aggregate are started to the job, the contractor, with the assistance of a competent inspector, should begin at once to exert every precaution to prevent overrun or loss of materials.

The following items should be carefully observed and controlled to obtain the maximum saving in materials:

Checking shipments of material as to tonnage and quality.

Storage of material and safeguarding against weather.

Specification requirements for large amount of materials in storage ahead of construction.

Number of times aggregates are rehandled entailing loss with each handling.

Measurement of aggregate. Bulking action of sand. Variation of voids in coarse aggregate.

Number of handling of cement with loss for each handling.

Method of delivery of batched material to mixer and effect on condition of prepared subgrade.

Subgrade:

Soil conditions.
Weather.
Whether a graded section or not.

Fine Grading:

Soil conditions.
Care with which rough grade has been done.

Method of setting forms and resurfacing.
Subgrader.
Specification for rolling, and watering.
Cross section of completed subgrade.
Method and specification for testing subgrade.

Mixing and Finishing Pavement Slab:
Stability of side forms.
Correctness of finishing template.
Consistency of concrete.
Method of finishing.
Wastage over forms.

Main Causes of Overrun.—A survey was made of many state highway departments from coast to coast, and in reply to a questionnaire the consensus of opinion attributes the cause of overrun to two main items.

First—The measurement of aggregate.
Second—The correctness of the subgrade.

The replies also indicated the interest and effort that is being made to meet the conditions and eliminate the objectionable features connected with the problem of overrun of materials, including cement, in highway construction.

Bulking Action of Sand.—First, under measurement of aggregates, we will discuss the bulking action of sand. It is well established that fine aggregate or sand is subject to bulking due to the natural moisture contained. It is safe and conservative to assume that when a cubic foot of commercial stock pile sand is measured out loose in a box, the volume of sand will shrink about 25 per cent if the sand is either completely dried out or saturated with water.

This is exactly what takes place on the paving job where bulking is not corrected. The bulk sand is introduced into the mixer drum together with the cement, gravel or stone, and water. Immediately when the sand and mixing water make contact a decided shrinkage takes place.

Let us examine the effect on quantity of materials used.

Assume a 6-bag batch of 1:2:3 mix which would nominally contain 6 sacks of cement, 12 cu. ft. of sand and 18 cu. ft. of coarse aggregate. The sand, when measured by volume without correction for bulking, will shrink to approximately 9 cu. ft. and instead of placing 36 cu. ft. of sand, coarse aggregate and cement into the mixer for each batch, there are only actually 33 cu. ft. present. It will be found that the yield of concrete suffers a loss on this account of over 8 per cent and it is almost directly proportional to the true volume of materials going into the batch.

Taking a mile of 18 ft. concrete road of 7 in. uniform thickness, we find that a 6-sack batch, of 1:2:3 mix, is designed to build 2.266 lin. ft. of such pavement. Actually when bulking of sand is not corrected, it will only build 2.075 lin. ft. of slab. Theoretically there would be required 2331 batches to build the mile of pavement, but due to the bulking of sand 2,545 batches will be required. If this bulking is not corrected this is what happens.

The extra cement used is $(2545-2331)\times\frac{6}{4}$ equals 321 bbl.

The sand saved is $(2331\times12)-2545\times9$ equals 187.6 cu. yds.

The extra coarse aggregate is $(2545-2331)\times\frac{18}{27}$ equals 142 cu. yds.

The amount of bulking will be from 20 to 35 per cent depending on the nature of the sand and the moisture present. Reference is made to the magazine "Public Roads" dated July, 1924, citing the entire data regarding the bulking of sand both out on the job and in the laboratory. There are numerous other authoritative references on this subject.

Methods of Correcting Bulking of Sand.—This bulking of sand should be corrected. There are now definite and accurate methods which accomplish this. In volume measurement of sand the measure can be set sufficiently large to correct for bulking.

The weighing method has been adopted or is permitted in a number of states (California, Iowa, Tennessee, South Carolina, New Jersey and Missouri).

Under this method the batch of sand is weighed out as so many pounds based on the dry weight of the material without regard to the volume condition of the sand in the stock pile or cars.

A further refinement of the weighing method is to allow for the weight of water in the aggregate. This is ordinarily done by ascertaining the average moisture content of the sand.

A sample of the stock pile sand is weighed, then dried over a fire and again weighed bone dry. The loss in weight due to evaporation of moisture is then taken as the percentage of moisture by weight for the stock pile. This is a simple practical test which can be performed rapidly, without any complicated equipment and with great ease. The batch weight of sand is increased sufficiently to correct for the weight of water contained in the material.

If the stock pile varies in moisture from the average condition assumed, the error introduced is far less than where the material

is being measured by volume, as the bulking fluctuates rapidly with changes in moisture content.

The weighing method has been practically applied to concrete paving operations with great success. From the contractor's standpoint, weighing of aggregate involves no delays in the operations. Equipment has been perfected for more than three years to weigh aggregates with no loss of time other than that required with a batcher.

Within the past year the inundation system has been perfected and marketed for measuring fine aggregate in a saturated condition. Saturation automatically destroys the bulking of sand and places it in a condition where it can easily and rapidly be measured by volume. Inundation shrinks the sand to a constant volume basis just as if it were bone dry and not bulked. Inundation further brings each batch of sand up to the point of saturation, thus nullifying the effect of varying moisture content of the sand on consistency. This enables the contractor to control the consistency of the concrete with greater ease. The outstanding feature of the inundation system, is that it destroys the bulking of sand and insures correct water measure without any tests whatsoever as to the natural condition of the aggregate.

Grading of Coarse Aggregate.—Correct measuring of the coarse aggregate as far as actual volume is concerned has been well taken care of. Practically all trouble encountered has been a result of the grading of the material by the producer, or if delivered correct in all respects by him through separation of coarse and fines, due to improper handling by the contractor. The variation of grading in coarse aggregate also has its effect on the yield of concrete. If the cement factor is based on a normal grading of coarse aggregate from ¼ in. to 2½ in. in size, and the grading changes so that nearly all the fines or material below ¾ in. is omitted, the reduction in yield of concrete will be approximately 4 per cent (See "Public Roads," July, 1924, page 23).

In actual costs this means about one-half of the overrun of materials computed under bulking of sand. Contractors have been lax in their attention to the materials delivered to them for use in concrete, particularly in regard to coarse aggregate. They have not considered the question of choice of kind, nor have they, after purchase, inspected or tested to determine for themselves whether the aggregate they are paying for does come up to the specifications under which it was purchased; neither do they give the attention to the handling of coarse aggregate that is necessary to secure the best results.

Materials passing the specifications on board cars can be changed into various gradings by handling and storing, and correct materials properly stored can be rehandled in such a way as to almost wipe out the efforts that have gone before.

This is not the right attitude necessary to prevent overrun. Contractors should insist on everything necessary being done by their organization on a job to correct it.

Coarse aggregate is usually condemned by the engineer for other reasons than for lack of fines. Material producers know that an excessive addition of fines will cause their product to be rejected much more quickly than thru lack of them. Therefore, they will play safe along that line, to the cost of prevention of overrun.

As to the choice between crushed stone and gravel, much has been said as to the results obtainable in their grading under present methods of production; also as to the effect of the use of either on quantity and quality of concrete produced. This also is worthy of investigation.

As proof of the extent to which fines are lacking, one of our leading eastern state highway departments estimates that 50 per cent of the coarse aggregate for their paving work was deficient in the small size of material, and of course a corresponding loss was suffered in construction.

The Rough Grading.—In discussion of correctness of subgrade, grade, and its effect on overrun, it will be necessary to consider first the weather, soil conditions, and the skill used in completion of rough grading, as three very important factors.

Wet weather is a destructive force hanging over the entire construction process and effects overrun or underrun to a greater or less degree depending on the soil conditions, method of delivery of batches to mixer, the season of the year and contract duration. When hauling is done over subgrade by trucks on certain soils, the only sure way to prevent overrun or underrun is to stop placing of concrete until suitable conditions exist, or plank the subgrade to prevent its destruction.

Rough grading built with care, brought to as near final grade as possible, for the full width of the roadway and sufficient distance outside of form line, will tend greatly to reduce overrun.

Rough grade should be kept uniformly high always, assuring that in the setting of forms that they will not rest on a fill, and that all fine grade be made in cut, without the moving of excess earth. That most contractors do not draw the distinction close enough between rough grading and final subgrading is made evident by a visit to their work. Usually it

is found that instead of a small force turning a well prepared rough grade into a stretch of completed fine grade, that a mixture of teams, tractors, and men are more or less rough grading between the forms, and that all is haste and hurry, with resultant losses thru faulty formsetting and subgrading.

The Forms.—The selection of forms suitable to meet the conditions to be encountered is a very important. Forms that will serve with certain soil conditions are not fit for use on others. Selection should be made with the following qualifications in mind.

Section must be strong enough to take loads and impacts of subgrader and finishing equipment without deflection or distortion, and the area of base of form sufficient to sustain the required load upon the particular soil encountered.

Design of form must be such as to withstand side thrust of subgrader and finishing equipment and the lateral thrust of concrete.

Staking arrangement should be such as to give added support to side form over and above that provided by the subgrade by means of a locking device, a positive and effective method of fastening joints and preventing deflection at that point. Staking method and locking device between forms should also be such as to enable easy readjustment.

Forms should be carefully set tight to line and slightly above grade before subgrading operation. If displaced by subgrader care must be used in resetting and surfacing. Usually on account of the effort necessary to remove forms and retrim directly under them, the practice is to resurface to high points by the raising of the other sections, resulting in many instances in increased thickness of slab.

Too much attention cannot be given to forms and form setting. Investigation will show that increased width and excessive or insufficient depth of slab are bound to follow lack of attention to this item. It is suggested that forms be set upon stakes driven to grade where the soil conditions are so poor that the form cannot be supported otherwise.

The Subgrade.—Subgrading machines, of which there are several types, are not made for heavy excavation as most of us have found out, but should be used for light trimming. If used with care, making a gradual approach by light cuts to final grade, low subgrade will be avoided, and the form line kept in almost perfect condition.

Tests should be made on subgrade to find out the amount of compression due to rolling that must be allowed for. This is important and will depend on the weight of roller required, the soil conditions and may further be effected by requirements of specifications as to the amount of rolling specified.

Several states require the final cut on subgrade to be made between the mixer and the place of depositing concrete. This is accomplished by attaching a special make of subgrading template to the mixer, that is pulled forward at each move of the paver.

Satisfactory results tending to correct overrun are obtained by this method if the subgrade has been left uniformly high, taking into consideration that only a very light cut can be made for final completion by the drag template. In case of low subgrade no filling is allowed, therefore no result is accomplished other than that it is apparent that extra concrete is being placed.

As stated before, contractors must remember that there is a direct bearing of one operation upon another in the final effect on overrun and underrun of materials used and that the correctness of the subgrading operation is the climax in the prevention action.

A summary of recommendations to assist in a solution of prevention of overrun through subgrade deficiencies should include a requirement for additional footage of forms set and subgrade prepared, watered and rolled ahead of paving operation; with requirement that all subgrade be made uniformly high and to proper section for final completion by drag template; the stopping of all hauling directly on prepared subgrade; a further refinement of the subgrading machine; changes in length of mixer boom and design of bucket to enable further development and use of drag template.

The effect of incorrect methods of mixing and finishing upon overrun and underrun is less than the other operations mentioned and are subject to correction much more readily. Consistency of concrete should be kept well within the range of a workable mixture, dependent on the ability of the finishing equipment to handle it.

The Finishing.—Finishing machines will successfully handle concrete produced under the slump test usually specified, if the grading of aggregate in the mix is correct, and will do so without loss over sideforms. However, care must be used in checking strike off and tamper as to their correctness in crown and shape with respect to finished surface as specified, and their adjustment one to the other. This check should be continued throughout the laying of pavement as it is impossible for adjustment of strike off and tamper to become loose and drop, or an operator in adjusting the machine to reset higher than necessary. Also watch that the scrapers that are supposed to clean the top of form ahead of finisher wheels, are adjusted so that they do provide a clean track for the machine.

In operation of finisher a regular procedure should be worked out and followed. It is the tendency to do as little with the finisher as possible. The average operator has no idea of the importance of the position he holds in its effect on overrun, and in his efforts to carry out his instructions "To keep up with the mixer" does a haphazard job of striking off the concrete.

Even the puddlers or levelers also play their part in preventing or helping overrun occur, preventing by careful leveling the batches making it possible for the finishing machine to do its work correctly, and stopping unnecessary spilling over top of forms, or helping by careless leveling that forces the finishing machine to do extra work with a sacrifice of concrete in wastage and extra depth.

Few contractors have figured out the loss (overrun) caused by a variation of ⅛ in., ¼ in. or ½ in. in thickness of pavement. When they do awaken to the facts, losses from overrun will receive concentrated preventative action.

Again, contractors do not want to lose sight of the fact that prevention or stopping of cement overrun means stopping of losses in the other material as well; that the preventative action is a step by step process in construction with a successful ending dependent on a knowledge of effect of each step on the result obtained, and their connection and importance to each other. Also that application of this knowledge in construction required positive supervision and checking throughout the entire job.

Lack of information has been the cause of the attitude of the contractor towards the inspection and supervision of the engineer. The contractor, fighting for production, has viewed certain requirements only from the side of immediate cost in labor, while the engineer saw beyond to the result on materials and quality. It is more through their efforts and guardianship that our attention has been called to the importance of this subject to us in construction.

Motor Vehicle Registrations Since 1912.—The following table from the annual statistical review of the Goodrich Tire & Rubber Co., shows the registration of motor vehicles by years since 1912:

1912	1,010,899
1913	1,248,056
1914	1,768,963
1915	2,494,912
1916	3,584,567
1917	4,970,671
1918	6,105,588
1919	7,596,502
1920	9,206,141
1921	10,505,630
1922	12,299,770
1923	15,312,658
1924	17,897,609
1925	20,229,025

New Trailer Batcher Bin

A new trailer batcher bin, so constructed that it can be moved completely assembled by two men without removal of batchers, has been brought out by The Heltzel Steel Form & Iron Co., Warren, O. It is stated that this bin has been transported over highways for distances of more than 60 miles and through congested city traffic at an average speed of 10 miles per hour. The bin is shipped completely assembled on drop-end gondola cars, and is easily unloaded or reloaded without the use of a crane. It has a riveted connection which fastens on to the frame of any make of truck. The batcher is controlled by

New Heltzel Trailer Batcher Bin.

a single lever, which is stated to perform the complete operation of filling, cutting off, dumping the batch of sand and stone and closing the lower gates and opening the upper gates in less than 10 seconds. It is stated to have a batching speed of six batches per minute by one operator.

Large Paving Contract for Florida Development.—The D. P. Davis Properties, St. Augustine, Fla., has awarded a contract for building and physical development of Davis Shores totalling in excess of $8,000,000, to the Foundation Co., New York and Atlanta, Ga. In addition to buildings the Foundation Co. will pave the streets, lay the sidewalks, build curbings, install water and gas mains, all sewage disposal drains, erect lighting fixtures, and put all power, light and telephone wires in conduits and make them available for each lot owner of Davis Shores. There will be 44 miles of streets paved; which will be 100, 80 and 60 feet in width, depending on the amount of traffic for which they are designed. A total of 87.7 miles of sidwalks and the same amount of curbing will be constructed.

"Pay As You Go Plan" of Highway Financing

How Funds for Construction and Maintenance Would Be Obtained from Motor Vehicle Tax Described in Paper Presented at Annual Meeting of American Association of State Highway Officials

By J. T. DONAGHEY
State Highway Engineer, Wisconsin

"The Pay as You Go Plan" of Highway Financing is a subject which has in most cases been discussed purely from the angle of providing funds by one of the three following methods: (1) By a direct tax upon general property; (2) Issuing bonds for a term of years, retiring the bonds when due, and paying the interest annually by a direct tax upon general property; and (3) By issuing bonds and retiring the bonds when due and paying the interest annually with revenues from motor vehicles.

Many states or subdivisions thereof have financed highway improvements by some one of the three plans mentioned above and in but few instances can oponents of any of the three plans show where the public has not received reasonably full value for the funds expended and highway service to the extent of several times the total cost of the improvements. Even where bonds have been issued for the construction of highways, the same running for a period of 20 years or more, and the surface of the road constructed has become worn to such an extent that a new surface was required before the bonds were retired, it is not proved that the public which must finally provide the funds for retiring the bonds has not received a highway service several times the cost required to meet the bonds and interest. The very fact that the surface has become worn to such an extent that a new surface is required is good evidence that the traffic was extremely heavy. There is still available the basic portion of the road for future use; that is, the right of way, roadbed and drainage structures.

Many writers contend that general property should pay the cost of right of way, grading and drainage structures, and that a just charge against the motor vehicle would be to provide and maintain the wearing surface. This sounds like a reasonable solution of the problem and would be, could it be carried into effect in all instances.

The Value of Old Roads Before Improvement.—There is, however, one matter that few have taken into consideration when discussing highway financing, and that is the value of the present highways before improvement. Every American state or its subdivisions have a large mileage of public highways. These highways, when originally laid out and opened for travel, were an obligation against the taxable property of the subdivision, and the right of way, grading and drainage structures on this vast mileage that the road builders of today are inheriting was provided by a direct property tax. The taxpayers of the different units of government have from year to year expended large sums for the improvement of the old roads, which are not all a total loss when reconstruction is contemplated. I dare say that the average mile of public highway as we find it in the average unit of government today is worth to us when taken over for improvement not less than $8,000, and this sum must be considered when figuring the fair proportion that general property should pay by a direct tax.

Financing by Revenues from Motor Vehicles.—During the past five years public sentiment has gradually drifted toward requiring the motor vehicle to pay a larger share of the cost of improving the highways they use, and to provide a method whereby each motor vehicle owner pays in proportion to the amount of service he receives as nearly as can be estimated. This sentiment has resulted in practically every state in the Union adopting a gasoline tax, in most cases to supplement a former license fee. There is but little sentiment against a plan of this kind in those state that have adopted it, providing the motor vehicle revenues have been honestly and conscientiously expended upon highways in which the motor vehicle owners are interested. In fact, the general feeling of motor vehicle owners is that they would rather pay a much higher amount annually than they are now paying in order to get adequate highway service as soon as reasonably possible.

I propose to discuss the "Pay as You Go Plan" of Highway Financing by suggesting an adjustment in motor vehicle revenues to an annual amount sufficient to provide the

necessary funds to construct an adequate system of primary and secondary highways as fast as it is practicable to construct the same, and to maintain both the primary and secondary systems before they are finally improved as well as after, thus giving the motor vehicle owners the best possible highway service from the very beginning.

It is not a waste of motor vehicle revenues to expend the same for the improvement of earth roads by supplying a light gravel surface prior to their final improvement. Neither is it a waste of funds to maintain both the earth and gravel surfaces in an adequate manner at all times.

Application to Average State.—In discussing this subject, we will consider an average Mid-Western agricultural state. This average state has 80,000 miles of public highways. We will assume that 7 per cent of this mileage or 5,600 miles, constitutes an adequate primary highway system and will eventually require a high type surfacing, and that 10 per cent of the total, or 8,000 miles, constitutes an adequate secondary system, which should eventually be surfaced with gravel or some other light type of surfacing that will keep traffic out of the mud. In other words, 17 per cent of the total highway mileage of this average state should eventually be improved with some kind of all weather surface to properly serve traffic.

This average state has a population of 2,600,000; a true valuation of $5,000,000,000; and a motor vehicle registration of 600,000. We find these three important factors go hand in hand, and there is very little variation in the proportion of each in the several Mid-Western agricultural states. There is, of course, a considerable variation in the industrial states of the East and the undeveloped states of the West. Assuming that these three factors do go hand in hand in the average agricultural state, it matters but little in the long run whether highway improvement is financed by direct taxation or by a tax upon the motor vehicles, as practically every family in such states now own one or more motor vehicles. The principal provisions of a highway law should be to compel each user of the highway to pay according to the service he receives.

Cost of Owning and Operating Motor Vehicles.—To own and operate 600,000 motor vehicles in this average state will require the stupendous sum of $273,000,000 annually. This is an average of $455.00 per motor vehicle. Included in this cost is interest on the investment, depreciation, insurance, housing, plus the general upkeep and operating cost of the vehicle, which is conservatively estimated as shown below:

Six hundred million motor vehicles at an average cost of $750 represents a total investment of $450,000,000.

When you have applied the above estimates to your own car, you will agree that the figures used are thoroughly conservative. Each motor vehicle in this average state is now paying in license fees and gas tax $21 annually, which is but 4.4 per cent of the total annual cost of owning and operating such motor vehicle.

It is generally conceded that it costs 2 ct. per mile more to operate a car on an average earth surface than on a concrete or other high type surface and 1 ct. per mile more on an average gravel surface than on concrete or other high type surfaces. Assuming that these figures are correct and that the average car travels 5,000 miles per year, the difference in the cost of operating a motor vehicle per year on a concrete surface as compared with an earth surface is $100; the difference between a concrete surface and a gravel surface is $50; and the difference between a gravel surface and an earth surface is $50 per year. These figures, which I am sure are conservative, prove conclusively that the motor vehicle owner can well afford to pay much more annually towards highway improvement providing the funds are expended on the highways he uses and by so doing will have a net saving annually on the cost of operating his motor vehicle.

No plan of highway financing, where the motor vehicle owner pays the bill, is complete or fair unless it includes the construction and maintenance of roads other than a primary system.

Annual Fixed Charges

Item 1.	Interest on $450,000,000 at 6 per cent	$27,000,000	
Item 2.	Depreciation at 20 per cent	90,000,000	
Item 3.	Insurance on 1/3 of vehicles at $30	6,000,000	
Item 4.	Garage rent and storage at $30	18,000,000	
	Total annual fixed charges		$141,000,000

Annual Operating Costs

Item 1.	Tires and tubes at $75 per car	$45,000,000	
Item 2.	Gasoline, 350 gal. at 20 ct. per gallon	42,000,000	
Item 3.	Oil, grease, waste, etc., at $20 per car	12,000,000	
Item 4.	Supplies and repairs at $50	3,000,000	
		$132,000,000	
	Total annual operating costs		
	Total cost of owning and operating the 600,000 motor vehicles annually		$273,000,000

Use of Roads in Wisconsin.—In order to determine the roads which the motor vehicle owners use in Wisconsin, the highway department conducted a very interesting traffic survey during the summer of 1924 in several separate units of government, nine of which were agricultural townships located in different sections of the state. A representative of the Commission called upon every farmer living in each of the nine townships and got the following information from them personally:

1. How many miles of annual highway travel, both auto and team.
2. Miles traveled on primary or state trunk highways.
3. Miles traveled on secondary highways, in Wisconsin called County Trunk Highways.
4. Miles traveled on ordinary town roads.

A tabulation of the above information shows that 48 per cent of the farmer's total travel was on the state trunk highways or primary system; 29 per cent on the county trunk or secondary system; and the balance, 23 per cent on the ordinary town roads.

Distribution of Motor Vehicle Funds.—Fifty per cent of the motor vehicles in this average agricultural state are owned in the cities and villages and not less than 80 per cent of their travel is on the primary system. This would result in 64 per cent of the total travel being on the primary system and the balance of 36 per cent on other roads. This shows plainly that a proper distribution of the motor vehicle revenue expenditures must be made if we wish the whole people in the average state to be in general satisfied with the plan.

Assuming that 25 per cent of the 5,600 mile primary system now contains a satisfactory surface, to construct the balance, or 4,200 miles, with a high type surfacing, at $35,000 per mile, will cost approximately $150,000,000.

Assuming also that 25 per cent of the secondary system contains a satisfactory light surfacing, the remainder to be constructed with such would be 6,000 miles. This 6,000 miles would in many instances, require only a light surfacing of gravel and would probably average not more than $8,000 per mile, or approximately $50,000,000. This would result in a total construction cost of $200,000,000 to complete the improvement of both the primary and secondary systems, containing 13,700 miles, or 17 per cent of the total mileage, which will adequately serve more than 80 per cent of the population of this average state.

Ten Year Construction Period.—There is a limit in almost every state as to the amount of highway construction that can be performed annually at a reasonable cost. The necessary materials and their delivery, the engineering organization required by the state department, and the contractors' organizations necessary to execute the work must be taken into consideration. I believe, therefore, that in planning the completion of a program as outlined above, the construction should be spread over at least a 10-year period, which would result in constructing 300 miles of high type surfacing and 600 miles of light type surfacing annually, which I believe is as large a mileage as this average state can plan and construct at a minimum cost and provide the necessary funds on the "Pay as You Go Plan."

It might be interesting to know that, to construct 400 miles of 19 ft. concrete highways would require 20,000 carloads of coarse aggregate, 10,000 cars of fine aggregate, and 4,500 cars of cement.

To construct 600 miles of gravel roads would require 48,000 cars of gravel.

How the Maintenance Cost Would Be Paid.—In addition to the construction program, the mileage of both the primary and secondary system should be adequately maintained from the beginning. The annual maintenance cost on the primary system would probably average $350 per mile for the 10-year period, or $1,960,000, and on the secondary system $300 per mile, or $2,500,000, resulting in a total annual maintenance cost of $4,360,000. This annual maintenance expenditure would, of course, include many miles of light gravel surfaces, where gravel is available in order to make roads serviceable until such time as the final surfacing could be financed.

The revenues from the annual increase in motor vehicles owned and operated in this average state for the 10-year period will more than pay the maintenance cost.

This average state's share of Federal Aid funds will approximate $2,000,000 annually. This amount, together with the revenue from the 600,000 motor vehicles at $30 each, would produce a total of $20,000,000 annually, which, in ten years, would complete the two systems, resulting in a total of 5,700 miles of high type surfacing and 8,000 miles of light type surfacing.

Benefits to Motorists.—If each motor vehicle owner will analyze his own case thoroughly he can readily see that he would be money ahead at the end of the ten year period if he pays the difference between what he now pays and the average of $30, due entirely to the saving in the cost of operating his motor vehicle, say nothing about the added convenience and pleasure of having a satisfactory system of highways to use. In fact, he cannot afford to do otherwise.

Financing by Bond Issue.—Should this average state authorize the issuance of bonds for the purpose of financing the same program and spread the payment over a 20 year period, it would be impossible for them to construct

the entire system in very much less than a 10 year period, due to the time required to plan and execute the work and the delivery of the materials required.

The annual interest charges would increase the total cost of the system by approximately 50 per cent. While it would ease off the annual payment somewhat by being spread over a longer period of years, nevertheless, at the end of a 10 year period there will probably be just as many highway obligations facing us as there are today. We find that a highway constructed 10 years ago, considered very adequate at that time, is wholly inadequate today, and the highways built 10 years ago are either being widened at a cost equal to, if not greater than, the original cost, or are being entirely reconstructed with a pavement two or more times as wide as the former one, with better alignment, better grades and the elimination of all dangerous features as far as possible. The same conditions may not prevail 10 years from now if an adequate highway system is planned and completed in this average state, but it is a fact that no American state has as yet permitted their highway department to plan and construct a system of highways that is satisfactory from 10 to 20 years after the system's completion.

The motor vehicle owner must not get the idea that if he is taxed to construct this system of highways that his obligation ceases as soon as the system is constructed. The maintenance cost of the system must be paid annually, and it must be provided from the same sources. Therefore, the maintenance cost, plus the additional obligations that the system will entail from year to year, will necessitate the expenditure of not less than the amount of motor vehicle revenue required to construct the system is outlined, spread over a ten year period.

The $30 Tax as An Investment.—Going back to the cost of owning and operating a motor vehicle in this average state, which is estimated at $455. The cost of providing a track for the motor vehicle to operate on, we find is only 6 per cent of the total cost of owning and operating the vehicle. This small sum cannot in any way be considered determining factor in purchasing a motor vehicle. If you are willing to expend $455 annually to own and operate the vehicle, the additional $30 required to construct the surface to operate on at a minimum cost per mile is surely a good investment.

The fact that the motor vehicle is now about the only user of our highways makes it impossible to finance a highway system by any other method than increasing the motor vehicle revenues. If the users of the highways desire a satisfactory highway system in this average state within a reasonable period of years, the only sure method is for them to get behind a plan whereby the revenues derived from motor vehicles will be fixed at an amount that will annually produce the necessary funds to bring about the desired results in a 10 year period as outlined above.

The Advantages of a Steady Revenue for Highway Improvement.—Where a steady though moderate revenue is provided for highway improvement which avoids the uncertainty of legislative action, the highway department can place in effect a budget system for a long term of years, determine that a certain road can be maintained with the funds available until a certain year and provide the funds at that time for its construction. A moderate, steady plan of highway construction on the "Pay as You Go Plan" is far better for the material producers, transportation lines, contractors, engineering department, and, in fact, everyone financially or otherwise interested. It stabilizes the whole operation, permits ample time for properly planning the work, and prevents the state from being flooded with "hay-wire" contractors and "mushroom" material producers.

To construct a system of highways under the "Pay as You Go Plan" requires entire freedom from political control of funds. All sections of the state must be treated fairly and each year's funds be expended where most needed, traffic and other conditions taken into consideration.

Under the plan as outlined, this average agricultural state will have a very satisfactory highway system from the very beginning and a real system at the end of a ten year period. There will be no future obligations in the form of bond retirements and annual interest charges. Every dollar of the motor vehicle revenues from year to year will be expended in construction and maintenance of the highway system. This can truly be called a "Pay as You Go Plan" of highway financing.

Novel Plan for Checking Slopes

Because of the many and various materials encountered in excavation, and a limited width of right of way on the new Coast Highway in California, through the Malibu Ranch, it has been necessary to employ numerous slope angles for cut banks, ranging from ⅜ to 1, to 1½ to 1. In checking the various slopes, a 5-ft. straightedge is employed with cleats attached at the proper angle. They are arranged in such a way that when a cleat is held horizontal as shown by an attached level, the straightedge is on the proper slope. The straightedge is provided with six cleats on each side and can be used to measure the angle of twelve different slopes.

Arterial Street Planning in Cities

Experiences in Chicago Outlined in Paper Presented January 12 Before American Road Builders' Association

By EUGENE S. TAYLOR
Manager, Chicago Plan Commission

Sixteen years ago the plan of Chicago was prepared by a staff of technical experts headed by Daniel Hudson Burnham and Edward H. Bennett, working in close association with the members of The Commercial Club of Chicago. The plan was not confined to the corporate limits of the city, but went far out into the surrounding country, much as the regional plans of today do.

It contained provision for a system of main or arterial highways both within and without the city limits. The streets inside the city corresponded to what are nowadays usually called "major" thoroughfares, while the roads outside the city included our circumferential routes encircling Chicago, together with a number of diagonal highways radiating out from Chicago as the center.

The foundation of the street circulatory system in the Chicago Plan was an inner quadrangle of wide streets around the central business district. Supplementing this was a second quadrangle at a greater distance from the loop. From both of these quadrangles some nine or ten diagonal thoroughfares radiated outward.

The Chicago Plan Commission was created by the City Council in 1909, for the purpose of studying the Plan of Chicago. As it was a department of the municipal government, the Commission had to concentrate its attention upon those improvements in the plan which were entirely within the city proper. At this time it was also felt that since the plan itself contained a scientifically marked out program of basic street improvements, no detailed plans for those improvements could be intelligently laid out until the future character, extent, and development of the various districts within the city could be foreseen with some reasonable degree of accuracy, as the result of having the city zoned.

The Chicago zoning ordinance was passed in April, 1923, and shortly afterward the technical staff of the Chicago Plan Commission set to work upon the compilation of a plan of "major streets" for the city of Chicago. This was in line with the power granted to city planning commissions by a recent act of the state legislature of Illinois.

Co-ordinating City Streets With Highways.—The first question which arose in connection with laying out a major street plan for this city was one which always arises in cases of this kind: Should the plan begin with the city as the center and work outward, or should it begin with the metropolitan area around Chicago and work inward? Many regional planners seem to believe that the latter procedure is the better one, presumably because it is so much easier to carry on road work in undeveloped territory. This, however, was just the reason why we took the opposite view. Because it is so much easier to shift roads in sparsely settled territory than it is to change well-built-up streets, we concluded that the best method for us to follow would be to start with Chicago as the center and work outward—co-ordinating the major streets within the city with the radial and other highways in the metropolitan district.

The work of developing a major street plan for Chicago had scarcely started when a very comprehensive survey of street and highway traffic conditions in and around the city was made by the highways departments of the County of Cook and the State of Illinois, in co-operation with the United States Bureau of Public Roads.

Agreement Between Highway Agencies and City Plan.—This survey will no doubt be discussed in great detail by other speakers, but there is one phase of it which, possibly, no other speaker may consider sufficiently important to dwell upon at length that I should like to mention. To my mind it is one of the most important features of the entire situation, because I believe that it establishes a precedent that will be followed to an ever increasing extent in years to come throughout the country.

I refer to the agreement which was entered into between the various highway agencies already named and the Chicago Plan Commission as the representative of the muncipality. In suggesting that this agreement be made, the governmental officials said:

> "The City of Chicago, the County of Cook, the State of Illinois, and the contiguous states are now engaged in, and contemplate for the future, large and continuous programs of street and highway development within their respective jurisdictions to provide for the traffic; but the traffic, if permitted to flow freely, ignores the boundary lines of the several jurisdictions. It is apparent that if the street and highway facilities provided by these several agencies are to be of the greatest benefit to the general public, a co-ordination of highway planning and development on the part of these agencies is imperative.

"The recent joint traffic survey conducted by the United States Bureau of Public Roads and the Cook County Highway Department, as well as traffic studies made by the State of Illinois Division of Highways of the Department of Public Works and Buildings and traffic studies made by the Chicago Plan Commission, all accentuate the necessity for immediate action and point the way to a definite program of co-ordination and co-operation.

"Therefore," these officials continue, "this memorandum of agreement between the various undersigned agencies interested in and responsible for the planning of highway facilities, is entered into and established."

The several parties agree:

1. To provide for the exchange of information, data, and statistics bearing upon the traffic problem in this area.
2. To co-ordinate the highway programs of the various agencies into a single major plan.
3. To give as rapidly as may be practicable, relief to present areas of congested traffic by adopting a sequence of highway and street improvement which will simultaneously make available continuous traffic routes through the several jurisdictions.

The parties also agree that after adoption by the several agencies of a definite major plan of highway and street development, no deviation from this major plan will be made by any one of the several agencies without a conference with all the parties to this agreement, for the purpose of mutual adjustment to preserve the integrity of the plan as a whole.

And they further agree that work on the major plan shall be completed as rapidly as practicable, and that at least one conference annually shall be held by the participating agencies for the purpose of making such alterations and revisions of the major plan as are necessary to serve traffic needs.

I have quoted from this agreement so fully because to my mind it points the way to the proper, logical manner of arterial highway development. It always happens that there are in all cities certain routes of vehicular travel which are of much more benefit to the city as a whole than to the various immediate neighborhoods through which they pass.

Such routes, to function properly as arterial highways, might require a width double that required for local purposes. Where such streets are widened as local improvements, and the local need does not require the width demanded by the arterial function of the thoroughfare, it is apparent that these streets come within a special class, and other means of paying for the widenings than by charging the entire or principal portion of the cost upon the abutting and adjacent property should be found. If such streets as these form part of a well-thought-out, comprehensive plan of major street and highway development for an entire region, it seems to me that herein would lie the best argument for proving their large public benefit and the need for them.

In accordance with the agreement which I have described, we submitted to the other governmental agencies the various thoroughfares which at the time appeared most likely to be incorporated in our major street plan for the city, when completed. Supplementing this we also submitted a copy of the through-traffic street plan which we were developing for and at the request of the City Council Committtee on Efficiency, Economy and Rehabilitation. This through-traffic street plan has now been completed and was presented to the City Council by that committee on Dec. 9, 1925.

The through-traffic routes of which it is composed connect with practically every existing and proposed highway route that reaches the city limits of Chicago. They will provide direct, continuous, and protected routes of travel from end to end of the city in all directions. They have been planned at intervals of approximately one mile apart, both north and south and east and west. The routes are 44 in number. Twenty-five of them extend east and west; 15 north and south; and four are diagonals.

It is our belief that the establishment and improvement of this system of through-traffic streets will go a long way toward solving Chicago's problem of street congestion and traffic movement, as it will disseminate and facilitate street traffic throughout the entire city by providing protected, well-paved, lighted and marked, direct and continuous through routes for rapid vehicular traffic all over the city, in every section, extending in all directions from city limits to city limits, and there connecting with the principal highways leading to and from Chicago.

Junior Highway Engineers Wanted.—The U. S. Civil Service Commission, Washington, D. C. has announced an open competitive examination for Junior highway engineers to fill vacancies in various branches of the Government service throughout the United States. The entrance salary in the District of Columbia is $1,860 a year. After the probationary period required by the civil service act and rules advancement in pay may be made without change in assignment up to $2,400 a year. For appointment outside of Washington, D. C., the rates will be approximately the same. Promotion to higher grades may be made in accordance with the civil service rules as vacancies occur. The duties of this position are to perform such work as drawing up plans for minor projects, performing field work, making computations, preparing maps, compiling reports, and handling technical correspondence. Competitors will be rated on general physics; pure mathematics; and practical questions on highway engineering, including applied mechanics.

Bituminous Treatment in Wyoming

Methods and Costs of Securing Uniformly Treated Gravel Road Surface of 1½ to 2 in. Described in November Wyoming Roads

By Z. E. SEVISON
State Highway Engineer

The Wyoming Highway Department completed during July and August the treatment of two sections of gravel surfaced roads near Laramie with results which indicate that the methods followed are adaptable on many of the other surfaced projects in the state. Numerous severe rains during the time the work was under way made it more difficult to secure uniform results and increased the cost somewhat.

Fig. 1—Federal Aid Project 152. Bituminous Treated Gravel Surface. Photograph Taken Several Weeks After Treatment.

Description of Projects.—These two projects are described as follows: Federal Aid Project No. 153, consisting of 3.94 miles of the Laramie-Cheyenne Road extending easterly from the end of F. A. Project No. 33, and ending in Happy Jack Canyon. This project was surfaced in 1924 with disintegrated granite commonly called Sherman Hill gravel, using the standard Wyoming section of 7 in. at the center and 3½ in. at the edges, compacted thickness, requiring 1,711 cu. yd. per mile, the average haul being 5.26 miles.

The second project consisted of 2.0 miles near the center of Federal Aid Project No. 152, which extends north from the city limits of Laramie. This project was surfaced in 1923 with pit run ¾ in. maximum size river gravel averaging rather high in grading under ½ in. The surfacing section was the same as for Project 153. About 15 per cent binder had been added during construction but this particular section, which runs through a gypsite soil, had never compacted satisfactorily and could not be maintained due to its breaking up under traffic. It was thought that this would prove as severe a test of road oiling as could be selected.

Method of Procedure.—Some variation was made in the methods followed on parts of these two projects in order to develop a procedure that would give the best results. As a result of this work of an experimental nature it was found that a firm, smooth surface easy to maintain could be produced.

The gravel surface is first scarified to a uniform depth of about 3 in. for the full width (18 ft.) and then shaped to a uniform cross section with a heavy blade grader. There is then applied 0.5 gal. of oil per square yard over one-half of the surface. The distributor

is immediately followed up with a tractor and blade which cuts off the surface to the depth the oil has penetrated, generally about 1 in., and shovels it to the center of the road. The distributor then applies another application of oil to the freshly bladed surface, giving it as much as will readily penetrate, which will be from 0.2 to 0.5 gal. per square yard. The tractor and blade are then used to spread the mixture of oil and gravel that was bladed to the center back over the freshly oiled sub-surface. This method is then followed for the other half of the road and finally if the resulting mixture does not appear uniform the whole surface may be given further blading so as to manipulate the oil and gravel until every particle of gravel is coated with oil.

It was found that this process of manipulation and distribution of oil on the sub-surface will produce a uniformly treated surface 1½ to 2 in. in depth, and one which will not seriously "mat" under traffic with proper maintenance.

Costs.—The total length treated on Federal Aid Project 153 was 3.94 miles and the amount of oil used per square yard was 0.57 gal. The costs on this road were as follows:

Engineering	$ 30.64
Repairing Surface	136.00
Hauling and distributing oil	272.61
Manipulating oil and gravel	367.33
Oil, 25,637 gal.	1,281.85
	$2,088.43

Cost per mile, 18 ft. road—$530.05.
Average haul of oil—6.0 miles.
Weather conditions unfavorable, amount of oil used is low but probably characteristic of surface.

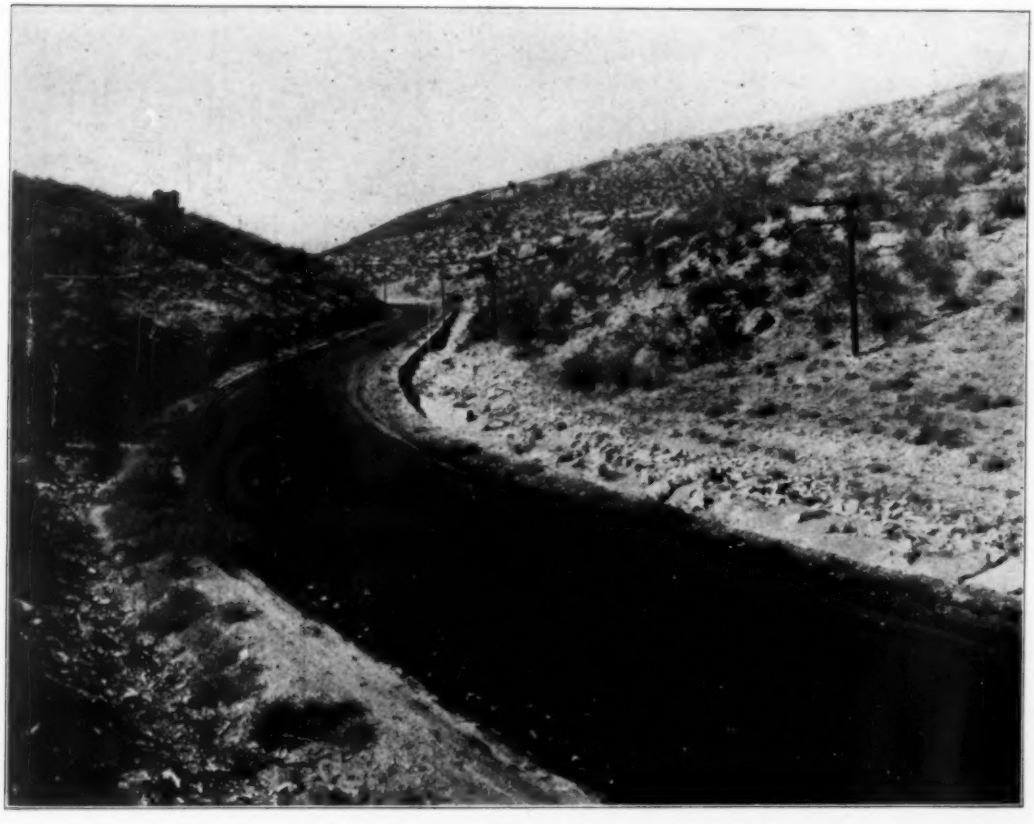


Fig. 2—Federal Aid Project 153. Disintegrated Gravel Surface. Photograph Taken 7 Weeks After Treatment.

The total length treated on Federal Aid Project 152 was 2 miles, and the amount of oil used was 0.68 gal. per square yard. The costs were as follows:

Engineering	$ 18.39
Repairing Surface	75.60
Hauling and distributing oil	133.35
Manipulating oil and gravel	263.63
Oil	838.25
	$1,319.22

Cost per mile, 18 ft. road—$659.61.
Average haul of oil—4.5 miles.
High cost due to very unfavorable weather conditions.

The entire cost, excepting the oil, varied from $200 to $240 per mile. The oil cost 5c per gal. at the refinery in Laramie.

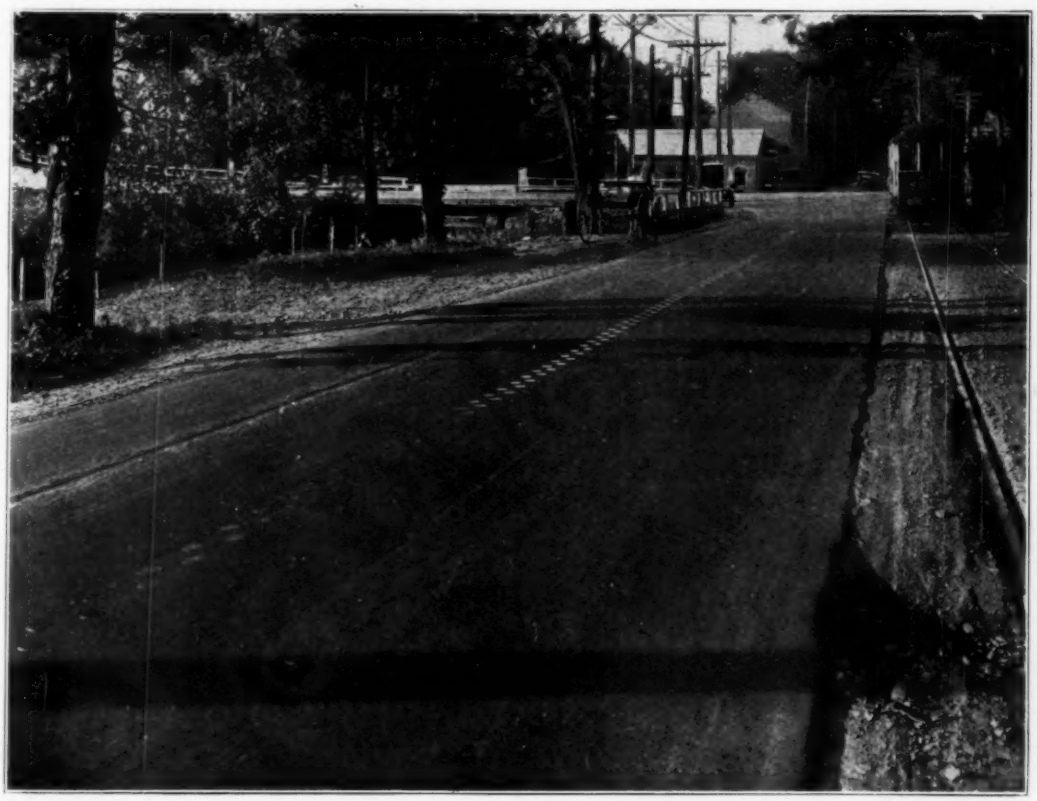
It is realized that a final conclusion as to the value of this treatment cannot be reached until after the projects have gone through the Winter, but the experience on Project 33 treated in 1923 indicates that these projects should be in good condition at the end of one year. It is probable that re-treatment to the extent of reshaping and applying about ¼ gal. per square yard will be necessary at the end of one year, and subsequent re-treatments will be dependent on traffic and weather conditions.

Brass Cups for Marking Pavements

A method of marking traffic directions in streets and roads by means of brass cups is a recent development of the Bridgeport Brass Co., Bridgeport, Conn. The cups are made in two diameters, 3 in. for pedestrian lanes and markings, and 4½ in. for traffic divisional lines. Designs for the layout of "traffic spots" are easily made with a rule, piece of string and a piece of chalk. Best results are obtained by inserting one 3-in. spot in every foot; that is, leaving 9 in. between the inner edges of the spots. The larger, or 4½ in. spots can be placed one spot in every 16½ in.; that is, leaving 12 in. between the inner edges of the spots. This spacing is recommended for lines but when laying out words or arrows spacing should depend upon the size of the marking.

Once the layout for any particular marking is made, the insertion in the pavement is accomplished by pounding (approximately half a dozen times) with a flat-faced, cast-iron road tamper. Another good method which is considerably faster, is to lay down the spots where marked and run a steam roller over them if a roller is in the vicinity of the installation. The spots are adaptable to asphalt, macadam, wooden block, amiesite, Warrenite and new concrete pavements.

Cost of Street Lighting in New York City.—The per capita cost of street lighting in New York City—the best lighted city in America—is less than 2/10 cents a day, according to a recent address by Arthur Williams, Vice-President—Commercial Relations of The New York Edison Co.



Traffic Line Made with Brass Cups

Firing Electric Blasting Caps

Recommendations Based on Bureau of Mine Tests Given in the December Explosives Engineer

To fire an electric blasting cap the bridge must be heated by a current of electricity to the temperature necessary to ignite the fulminate or other priming compositions. This current is less than that required to fuse the bridge wire for, ordinarily, a current of 0.4 amperes will fire a single cap and 0.5 amperes may be reasonably depended upon. The time required to properly ignite the priming composition with low currents may vary from 0.05 seconds to 0.2 seconds, even with caps of the same resistance. The difficulty presented by the variation can be overcome only by using a current so high that the bridge of the slowest cap in the circuit will be raised to the firing temperature before the quickest cap explodes, thereby opening the circuit.

It has been shown that an increase of 20 per cent in current was necessary to fire two caps in a series over that required for single caps. Under ideal conditions it was found that a current of not less than 1.0 ampere was necessary to fire 30 caps connected in series, and, therefore, to insure sufficient current to fire a large series of caps under working conditions, not less than 1½ amperes should be used. This allows a 50 per cent factor of safety.

Tests of U. S. Bureau of Mines.—The Bureau of Mines has made some rather exhaustive tests to determine the cause of failures of center shots in blasting.

The results of their tests indicated that, "if a large number of the common electric detonators are connected in series and fired under wet earth conditions, a large leakage of firing current occurs, and the detonators at each end of the series circuit may fire while the middle ones misfire. The detonators near the positive end will fire because not enough leakage has occurred to cause a misfire; those near the negative end will fire because enough current has returned to the circuit.

"The reason why the middle detonators misfire is not necessarily because the current through them is too small to fire an electric detonator, but because it is not sufficient to fire them before the firing of the end detonators has opened the circuit. It has been found in practice, using hand-operated machines, that such misfires are more dependent on the current gradient in the circuit than upon the minimum value of current, and that it does not help much to increase the firing current to the amount given by a larger hand-operated machine."

The usual conditions encountered in blasting allow more or less leakage so that the Bureau's conclusions may be directly applied, to a certain degree, to practically all blasting conditions. It is, therefore, recommended that a straight series connection always be limited to not more than 50 caps.

With the usual type of blasting machine only straight series connections should be used. The method of connecting when using a power circuit, depends upon the available current and the number of caps to be fired, but where possible, the straight parallel circuit should be used.

Recommendations for Firing.—The following currents are recommended for firing electric blasting caps with different systems: For straight series connections, not less than 1.5 amperes should be used, while straight parallel connections require at least 0.5 ampere for each cap. When connecting series of electric blasting caps in parallel 2.0 amperes a series are necessary, and for groups of electric blasting caps with the caps in parallel and the groups in series, the amount of current needed is not less than 1.0 ampere for each cap in the largest group.

Determination of Voltage Required.—The basis of calculations to determine voltage necessary for a given circuit is Ohm's law:

$E = IR$ where
E = voltage in volts
C = current in amperes
R = resistance in Ohms

To find the minimum voltage necessary to put the 1.5 amperes through a series containing 1000 ft. No. 14 B. & S. gauge copper lead wire (2.52 Ohms,) and 10-30 ft. copper wire electric blasting caps (10x2.00=20.0 Ohms), substitute in the above formula, and the result is $1.5\ (20.0 + 2.52) = 33.78$ volts.

Standard Resistances.—The following standard resistances of several sizes of copper wire, B. & S. gauge, in Ohms a thousand ft. are:

No. 4	0.248
No. 8	0.628
No. 10	0.999
No. 12	1.588
No. 14	2.525
No. 16	4.015
No. 18	6.385
No. 20	10.15
No. 21	12.80
No. 22	16.14

Iron wire has approximately six times the resistance of copper wire of the same size and length.

Locating Rural Highways

General Principles Given in the Following Summary of Paper Presented Jan. 12 at 23rd Annual Convention of American Road Builders Association

By COL. W. W. CROSBY,
Location Engineer Pennsylvania Department of Highways

Until recently highway engineering has been engaged mainly in superficialities. The surfacing of roads and streets, with the details that entered the considerations of the construction, reconstruction, and maintenance of modern surfaces on the old routes or layouts has been the main occupation of highway authorities generally. Road-building has overshadowed highway engineering.

Is it now not time to lift our noses from our grindstones and look ahead questioningly, with a view to conclusions as to whether or not the highway locations that are now being superficially improved with modern durable roadways will be any more free from criticism well within the life of the surfacings being provided than are the old alignments of yesterday?

And is it not up to the highway engineer to lead rather than to be driven by the public in this matter?

Two Kinds of Highway Location.—Highway location may be of two sorts: (a) Actual location where none now exists, or relocation and line revision partly over old rights of way and partly over new: and

(b) Selection of existing routes first, with then the operation of "a" above.

So far selective location (b) has been mainly political. A few instances exist where engineering advice entered but it seems safe to state there is none where it has been given proper opportunity or effect. We are just beginning to be aware of the fundamental importance to the State and to the Nation of advanced engineering conceptions in this matter of Highway Location by Selection, and there is great need for preparation by Highway Engineers to fulfill their responsibilities in this connection.

This preparation can probably best be made through studies and practices under (a), which for convenience hereafter may simply be considered in the light now of relocation and line revision in cases of existing routes of public travel.

All are familiar with the defects of old alignments, such as abrupt turns, excessive grades over hills, or detoured roadways around fields valuable for crops, and of the desire or need for remedying to the ends of convenience, economy and safety for traffic, such defects by relocations of the highway. These same problems magnified take the aspect of more direct and better graded routes, by-passes of congested centers and even of a better correlation of highway transport facilities with those of rail and water.

The Fourth Dimension of Highway Location.—A successful approach to any specific problem of highway relocation or line revision involves a comprehension of the traffic changes that have occurred and a reasonable anticipation of further developments on that line. But beyond this recognition of that subject this paper will not dilate on these matters further than to point out here, once and for all, one fact. It is this: highway location must now and hereafter recognize the existence of a sort of fourth dimension in its problems. That fourth dimension is speed (or time), which is to be added to the other dimensions of length, width (or breadth), and thickness (or profile, i. e. grades).

When the problems under discussion shall have been solved in the four dimensions noted —or even during its solution—the economic factor is reached, and this may also involve a social factor more or less resembling a political one sometimes.

Frequently the highway engineer is not in a position to consider the question beyond the purely economic side though he may be and should strive to be prepared to do so. But usually he must hold some sound ideas up to and including the economics of location questions, and he may even needs to have a proper comprehension of sociology.

Sound Conclusions Needed.—There is at present need among the profession, and even greater want outside of it, for sound conclusions on a number of points directly affecting the solution of location problems—even in line revisions—and concerning such primaries as—

The costs of length, which are economic;

The effects of grades, which are both physical and economic;

The effects of curves, which are physical;

The propriety of speeds, which are both physical and economic; all in connection with modern traffic on the highways and the developments of this traffic reasonably to be expected

and to be provided for within say the next score of years or the expected life of the roadways now being provided by either bond issues or taxation.

Conclusions on these points as well as on many minor principles or other equally important ones do not seem to be as yet sufficiently widespread or developed to meet the needs. There is a pressing demand for them and it is to be hoped that some may soon be reached by this avenue for approach through this meeting and this powerful association.

Some states have recognized the importance of some of the problems of highway location and perhaps Pennsylvania has advanced farther directly in this matter than any other. In illustration, therefore, of what has been said and in exposition of the Pennsylvania consideration of location problems, it may now be best to cite a specific case that came up in 1925 in that state.

Specific Example of Highway Location.—State Highway Route 153 was established by the legislature (and later officially selected as a primary route of the system) to begin at Philadelphia City near Chestnut Hill, and

> "Thence running by way of Fort Washington, Spring House, Montgomeryville and Colmar to a point on the dividing line between Montgomery and Bucks Counties; thence to Line Lexington, Sellersville, Rockhill and Quakertown, to a point on the dividing line between Bucks and Lebanon Counties; thence by way of Coopersburg to a point on the boundary line of the City of Allentown, Lebanon County."

The old road identifiable by the above description has been marked on the published maps of the department as a primary state highway route.

It has been held by the legal authorities of the state that the highway department must improve or maintain the route between Philadelphia and Allentown as identified by the legislative description, though the improved roadway may vary from the original or present public road or right of way between those points, provided that, if the new highway shall be relocated so as to by-pass the intermediate villages or boroughs named, a proper connection or spur shall be provided by the state between each of these settlements and any relocation for the state highway.

Now in this case it appears that previously a modern paved roadway has been provided along the right of way of the old road from the point of beginning of the above legislative description (the Philadelphia City line at Chestnut Hill) for 7 miles to Spring House on route to Allentown (41 miles from Philadelphia) and that this roadway is satisfactory present requirements on it. From Spring House to Quakertown (20 miles) the present roadway is in such condition as to be reasonably sufficient for the present and no improvement is contemplated by the state for this section at present. The existing roadway of the established route from Quakertown to Center Valley (7 or 8 miles) is in such condition that its resurfacing must be done by the State at once. From Center Valley to Allentown (6 miles) the existing road, having been recently improved, may be taken as outside the present consideration.

The question that first arises, therefore, is as to just what location or alignment shall now be contemplated for the section of new roadway now to be provided on this route for the part between Quakertown and Center Valley.

Philadelphia, the third city in population of the United States, of course, is a large center of production and consumption. Allentown is a growing center, and, with Bethlehem less than 5 miles away, forms an important region for production and consumption. The distance between the two regions (Philadelphia and Allentown-Bethlehem) is well within the radius of efficient motor trucking operations over a direct connection by improved public highway. Such operations demand several provisions to be made properly: directness; avoidance of unnecessary length or excessive curvature and grades; sufficient widths; avoidance of local congestion and of danger; together with proper regard for local convenience and use of this route which for the present must be considered as a general purpose highway.

What the Transport Survey Showed.—It, therefore, seems necessary before the propriety of the present location of a section of the entire route can be determined, first to examine the route as a whole.

The transport surveys (of 1923 and 1924) show the following figures as regards the traffic use of this route—

Traffic Counts—1923

Location on Route	Av. Sunday (total)	Av. Daily (total)	Av. Daily (total)
Nine Separate Stations Average	3230	1540	275

Traffic Counts—1924

Location on Route	Classification	Summer	Winter	Av. Daily Traffic
Three Separate Stations Average	Trucks	164	129	146
	Passenger Cars	1542	823	1183
Total		1706	952	1329

It is apparent that the route may be regarded (relatively at least) as a heavily travelled one and one on which future traffic is to be much more severe and numerous within the

life of the more durable roadway now proposed to be built. The improvement of the roadway will accentuate these conclusions.

The present alignment of the route between the termini—and in some cases between the intermediate points mentioned in the act—is somewhat indirect and thus excessively long; the grades on the present alignment are more severe than are now or likely to be satisfactory; and congestion and dangerous situations for all traffic exist at numerous places along the present alignment. Discomfort, dissatisfaction and inconvenience also are suffered by the residents along the present roadway from the conflict of interests between the through or foreign traffic and the local enjoyment of the roadway.

Reference now to the map showing the route, its controls, and the topography reveals the following:

"An 'Air-Line' from the 'center of gravity' of Allentown and Bethlehem to Philadelphia passes through or close to Center Valley. This latter point is in a gap in the hills through which the route must come from the south into Allentown and Bethlehem, and also forms a convenient point for diverging from the air line by T's or branches to the individual centers of both these towns, which are about five miles apart and each practically the same distance from Center Valley.

From Center Valley southerly, to Philadelphia the air-line would pass east of the present location in the village of Coopersburg; through Quakertown; a little west of Rock Hill and of Sellersville; be nearly coincident with the present location at the Bucks—Montgomery County line; and then lie to the west of Line Lexington and of the present route through Montgomeryville, Colmar, Springhouse and Fort Washington to coincide again at the Philadelphia City line.

It has been noted that a roadway satisfactory for the present needs exists south of Quakertown. The net problem now is, therefore, the location above Quakertown to Center Valley, both these points being coincident on the present route and the air line. Whatever the future may hold for relocation below Quakertown (to Philadelphia) evidently no consideration of that section need now be included with that of the section from Quakertown to Center Valley.

Within the limits so arrived at for study as to improvement now with a durable type surface (i. e. between Beaver Run, south of Quakertown, and Center Valley), the air line is 6.85 miles or a mile less than the length of the present road. This air line appears impracticable as it cuts Quakertown and Coopersburg diagonally, which would cause excessive property damage and also introduce difficult and dangerous traffic conditions due to passing through main parts of the boroughs. It further introduces two railroad crossings with consequent problems and complications; does not fit the topography to advantage; creates a duplication of nearly parallel roads in certain narrow sections; does not serve rural interests to advantage beside causing excessive damages.

A study of the topographic maps available and covering a section between Rich Hill (just south of Quakertown) and Center Valley enables a suggestion to be made for a relocation on an approximate air line between these points that will offer many advantages, along the lines indicated before as desirable, such as greater directness, shorter lengths, better grades, avoidance of congestion, and other dangers to traffic. The relocation so suggested will also bring this section of the route very closely in alignment with the most direct route needed between the termini of Philadelphia and the Allentown-Bethlehem region, so that its improvement now would seem to form a real step toward what may be considered as an ultimately desirable establishment, though for some years to come the rest of the establishment may not be completed and the present character of the highway as a general purpose one but not a special industrial highway may be retained and that function of it served.

Recommendations of Location Engineer.—A preliminary field survey of the suggestion developed from the maps was, therefore, authorized and was made by the district engineer's forces. The location engineer, from the facts thus developed, then recommended to the engineering executive that the relocation be approved for reasons summarized as follows:

"The relocation (the approximate air line) shown on the attached print is in conformity with the requirements of the existing legislative act establishing this route.

"Scenic and similar considerations on the proposed relocation are equivalent to if not better than such features along the present route location.

"The proposed location will avoid, for through traffic, one grade and two half-grade crossings with the Lehigh Valley Transit Company (Liberty Bell Route) which exist on the present location of the route. However, the relocation will require the creation of a new grade crossing with the Lehigh Valley Transit Company at a point to the northwest of Quakertown Borough The present route, through the latter place, parallels the trolley tracks and consequently there is created a rather undesirable congested traffic condition along the present narrow built-up street (35 feet between curbs). The relocation avoids this unsatisfactory feature entirely.

"The character of the country traversed by

the relocation is mostly farming land. Between the termini of the two locations there are 13 houses and 2 schools along the relocation, and 143 houses, 5 churches and 2 schools along the present route. In addition, either of the locations serves Coopersburg (89 houses) and Quakertown (97 houses).

"The length of the present route is 52,712 ft. or 5,012 ft. more than the length of the relocation (47,700 ft.) which is an appreciable saving in favor of the latter on this important primary route. It will further be noted that the relocation as proposed conforms very closely to the ideal air line location between Center Valley and Rich Hill.

"The maximum grade on the present road is 7.94 per cent which extends for a continuous length of 1,025 ft. whereas on the relocation the maximum grade will not exceed 8 per cent for a length of 600 feet.

"The proposed line, in Quakertown Borough, will avoid an exceptionally sharp curve in a narrow and built-up section. This undesirable and dangerous condition that exists along the present route cannot be sufficiently modified to be satisfactory without involving excessive property damages. The alignment along the relocation is a vast improvement over that along the present route, the maximum degree of curvature being one nine-degree and thirty minute curve on the former as against a maximum of three fourteen-degree curves on the latter (exclusive of the present 60 degree curve in Quakertown borough).

Comparative Costs.—"It is estimated that the cost of construction on the present location would be $424,385 or $16,241 more than the estimated construction costs via the proposed relocation ($408,144).

"The present daily traffic is reported as 1,346 passenger cars and 183 trucks. The probable future daily traffic is estimated as 2,700 passenger cars and 400 trucks. Predicated on the latter traffic figures the economic formulae of this department show the following annual operation costs.

	Present Route	Proposed Location
Passenger cars	$ 941,654	$ 852,026
Trucks	531,195	476,552
	$1,472,849	$1,328,578

or an annual saving of $144,271 in favor of the relocation.

"The value of the land traversed by the relocation is about $125 to $200 per acre for farming land and about $50 per acre for marsh land, I am informed. The total land damages involved in obtaining the necessary lands for ultimate right of way purposes on this relocation would amount to approximately $15,350. In addition, the moving back of buildings to obtain a hundred ft. right of way with the incidental minor line revisions is about $150 an acre, involving total land damages of $12,300. Property damages on the old location, because of the built-up conditions now prevalent, would amount to about $285,600 in order to obtain the prescribed ultimate right of way width. Ultimate damages, therefore, would be $270,550 more along the present route location than via the relocation.

"No abnormal maintenance conditions nor unusual construction difficulties would be encountered along either of the locations considered."

Conclusions.—In conclusion it may be said:

Proper location will do much now to relieve promptly traffic dangers existing or imminent. Often we can "build the safety into the location."

The advances made in road building and in highway engineering during the past 30 years, and particularly in the last 10 years, warrant hope for even greater advances in the near future. But they also impose on those now active in the work responsibility for recognition of past errors; of advances to date; of present accomplishments, and for reasonable foresight as to future developments.

Mistakes today are not as excusable as they have been—

There are a number of lines along which further advance is needed in highway engineering such as, for instance, the relative effects of length, widths, grades, and speeds in the light of economics and social welfare as well as in that of mechanics or finance. And, highway location must be seriously considered as related to railroad, waterway, and even airway transportation and routes.

There is this final point the writer now wishes to make at this opportunity—

Mass production of roadway surfacings tends to interfere with the proper study of location problems. If the latter are to be properly solved, they must be contemplated and their solution begun well in advance of the annual construction program.

Street Sprinkling With Sea Water.—The use of fresh water has been discontinued and salt water again used for street watering in Cape Town, South Africa. This, states the city engineer, D. E. Lloyd Davies, in his latest annual report, necessitates longer haulage, but has been found more efficacious in allaying the dust nuisance. Altogether 32½ million gallons of water were used in street watering and gully flushing in the course of the 12 months covered by the report.

Resurfacing and Maintenance by Contract

The Possibilities of a Future Field for the Contractor Outlined in a Paper Presented Jan. 14 at 23rd Annual Meeting of the American Road Builders Association

By G. F. SCHLESINGER
Director of Highways and Public Works of Ohio

Any discussion of this subject involves the assumption of a considerable power of prophecy and ability to peer into the future. What we may look forward to in the development of highway transport in the years to come is indeed difficult to predict with any degree of certainty. The motor vehicle and the highway over which it operates constitute the most remarkable development in transportation that is recorded in history.

500 Per Cent Increase in Motor Vehicles.—A study of automobile production and registration in the past reveals an unprecedented rate of growth that was as a matter of fact practically impossible to foresee. It has been less than ten years since Federal aid for highway construction was inaugurated and many of the state highway departments in consequence of this policy have been established within this ten year period. In 1916 there were 1,617,708 motor vehicles produced in the United States (a gain of 81 per cent over the preceding year); and the total registration was 3,512,996 (or 44 per cent more than the preceding year). Today there are about 20,000,000 motor vehicles registered which is an increase of about 500 per cent. The quantity of motor cars in use has inspired and will continue to inspire many an end-to-end statistician with attempts to visualize the enormous numbers of these vehicles with well known but startling picturizations. In view of the unprecendented happenings of the past and the unknown possibility of the future it is believed that a 5-year period is of ample duration in which to discuss the future of any branch of highway development.

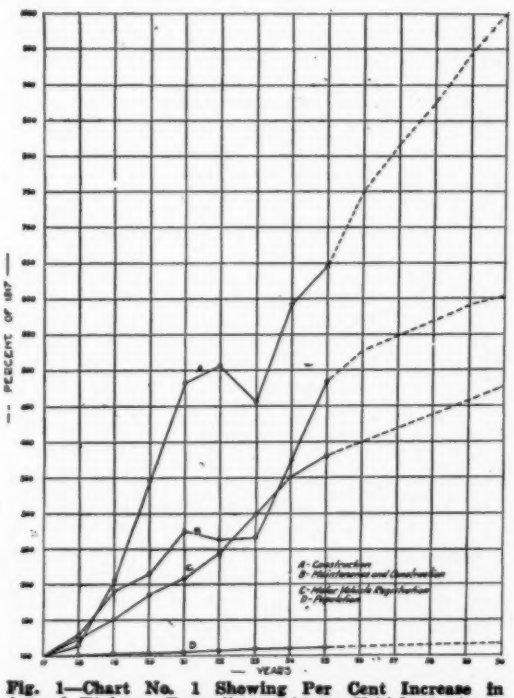


Fig. 1—Chart No. 1 Showing Per Cent Increase in Annual Highway Expenditures, Motor Vehicle Registration and Population.

The Term Maintenance.—The term "maintenance" as used in highway operations has no fixed and certain meaning, that is the same in all sections of the country. Generally speaking maintenance means to preserve something in its original condition. In some states all forms of maintenance repairs, resurfacing, reconstruction and even widening are classified as maintenance—frequently in order that they may be eligible to receive a certain class of appropriated funds. In the case of private industry, such as a railroad company, any expenditure on reconstruction that is greater than that required to "renew in kind" is classified as an addition and betterment charge and a strict accounting kept of the same. This addition and betterment account permits the company to increase its credit and borrowing powers. In public work there is not the necessity for a rigid distinction between maintenance and betterments. In this discussion routine maintenance, repairs, and resurfacing will be classed as maintenance and widening as new construction.

The fact that maintenance and reconstruction are necessary frequently calls forth criti-

cism and the "failure" of roads is a fertile subject of comment on the part of the public. The use of the word "failure" in this connection is unfortunate in that it implies incompetency, negligence, or culpability on the part of the highway engineer or highway contractor. That a so-called road failure is the fault of either the designer or constructor is not necessarily nor usually true.

Causes of Road Failure.—In the first place the introduction and extensive use of the motor truck with its heavy concentrated loads could not have been foreseen by the designing engineer any more than it was by the producer and the user of motor vehicles. The motor truck is now such a familiar means of transport that it is difficult for most of us to realize that its introduction as a factor in highway transport occurred only about 10 years

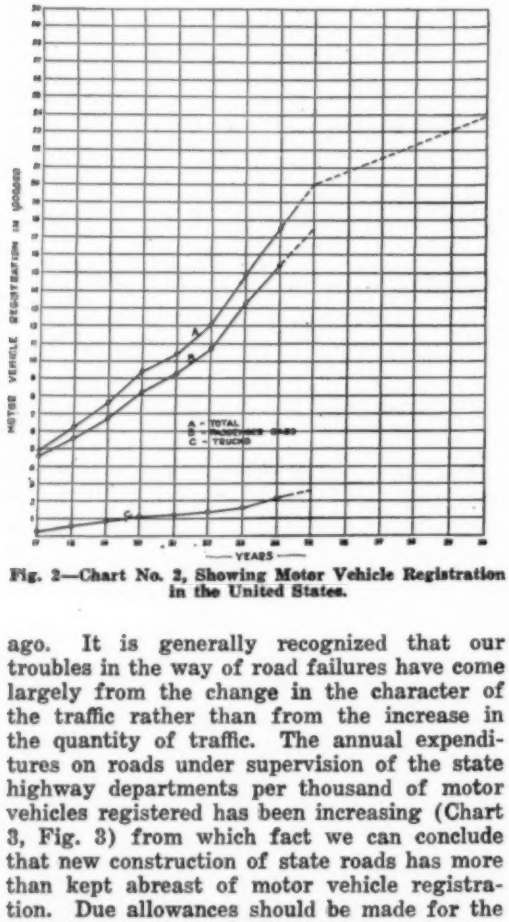


Fig. 2—Chart No. 2, Showing Motor Vehicle Registration in the United States.

ago. It is generally recognized that our troubles in the way of road failures have come largely from the change in the character of the traffic rather than from the increase in the quantity of traffic. The annual expenditures on roads under supervision of the state highway departments per thousand of motor vehicles registered has been increasing (Chart 3, Fig. 3) from which fact we can conclude that new construction of state roads has more than kept abreast of motor vehicle registration. Due allowances should be made for the fact that traffic undoubtedly increases at a greater rate than registration as the distance traveled annually per motor vehicle has increased with better highway facilities. Without raising the question as to whether the rate of new construction has been great enough it is apparent from data available that the sudden necessity for large reconstruction programs for the older highway systems has been principally due to the advent of motor truck traffic.

The motor bus which is now coming into extensive use will not introduce any increased concentrated loading. However, it will require that pavements be constructed wider than formerly.

It is expected that roads, like any other engineering structure or machine, will depreciate. Even with the most efficient maintenance a point is reached when it is more economical to reconstruct the pavement than to spend excessive sums in endeavors to prolong its life. When that point is reached the pavement has attained its "economic life." If we possess accurate data on initial costs, salvage values, and maintenance costs the economic life of a pavement can be determined. Whether the highways official is in position to act in accordance with the economics of the problem always depends on the funds available. Economically reconstruction may be proper but due to financial limitation we are frequently compelled to continue repairing the existing surface.

Stage Construction of Road.—The principal of stage or progressive construction of roads contemplates that the original surfacing is inadequate for the traffic that will be expected in the future. The engineer plans to use the existing road metal as a foundation for a heavier type of construction as funds become available with increased traffic. It is considered more economical to connect centers of traffic flow at one, and then later to build vertically rather than horizontally in order to meet the requirements of increased traffic and economic maintenance.

In certain types of construction, such as traffic bound gravel, stone or sand-clay, instead of periodic attention the maintenance work necessary consists of a constant renewal and reconstruction of the surface. As is well known, lack of attention for only a day or two will result in dismal failures in this type of road surface.

Advantages of Highway Research.—However, in connection with the subject of road failures the engineering profession can not be considered entirely without fault. Until comparatively recent years the knowledge of the art of road design, construction and maintenance lagged behind the increase in the volume of road mileage being constructed and maintained. The importance of highway research was not realized for many years. The fact that the highway engineers were too busily en-

gaged in a frantic effort to keep pace with the enormous increase in motorized highway traffic can be given as an extenuating reason. Progress in research due to a number of important investigational projects carried on by public and private agencies has resulted in more rational and economical design methods for all types of pavements. The establishment of the Highway Research Board as a coordinating agency insures for the future an efficient and proper dissemination of highway research knowledge among those who are responsible for the large road programs. A certain class of road failure is due to special causes, such as unusual rain storms, extensive land slides, effects of temperature, and traffic concentration due to deep snow. Many in this class are beyond the control of the engineer, or of such infrequent occurrence that it is not considered economic to provide against them in the design.

In this discussion conclusions regarding the amount of resurfacing and maintenance work have been based on the hypothesis that the forecast can be approximated by a study of the past development taking into consideration probable future conditions. No theoretical assumptions as to the economic life and annual depreciation of existing roads have been used. Existing data upon which to base such a line of reasoning are not available.

Future Motor Vehicle Registration.—An estimate of future motor vehicle registration is based on a normal increase in population and a normal increase in motor vehicle density (or motor vehicles per person). Expenditures for construction and maintenance are considered in relation to the numbers of automobiles registered. Graphical representations are used in the investigation and, as stated above, a 5-year period in the future has been selected.

On Chart No. 1 (Fig. 1) by projecting the population curve a population of 119,000,000 for the United States in 1930 is indicated. An assumption was made that the motor vehicle density in 1930 will be one motor car to five persons and the curve for the total motor vehicle registration on Chart No. 2 was projected accordingly. The ratio in 1924 in the United States was 1 motor vehicle to 6 persons, ranging from 1 to 3.38 in California to 1 to 17.49 in Alabama. As a result a total registration of about 24,000,000 motor vehicles in the United States in 1930 is obtained. It seems to be the opinion of many authorities that the peak of annual automobile production in the United States was reached in 1925 and that any increase in the future will depend on a larger foreign market. The trend of future motor vehicle registration, derived from Chart No. 2 (Fig. 2) but reduced to precentage, is shown on Chart No. 1 (Fig. 1).

Chart No. 3 (Fig. 3) shows graphically the annual expenditures for construction of state highways per thousand motor vehicles registered and also the same information regarding maintenance and reconstruction expenditures.

The analysis is based on expenditures by state highway departments. Statistics regarding expenditures by other political units or agencies are not extensive nor authentic, and also not subdivided between construction and maintenance.

It should be noted that the annual expenditure for maintenance per 1,000 motor vehicles

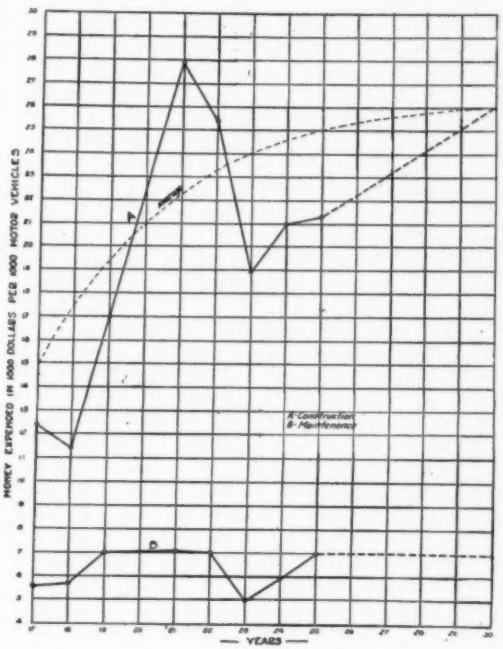


Fig. 3—Chart No. 3, Showing Annual Expenditures on Roads Under Supervision of State Highway Departments in Dollars Per 1,000 Vehicles.

has been a fairly uniform amount. In this analysis it will be taken as $7,000 as it is not believed that the average will increase. Widening, as stated previously, is not classed as maintenance.

Why Future Pavement Failures Will Not Be So Frequent.—Pavement failures will not be as frequent nor extensive in the future. This opinion is based on the following facts:

(1) There will be no great or sudden increase in concentrated traffic loads such as occurred when the motor truck came into general use. This is precluded by legal weight restrictions in the statutes of all states and more effective enforcement of traffic laws. In other words, the character of highway traffic

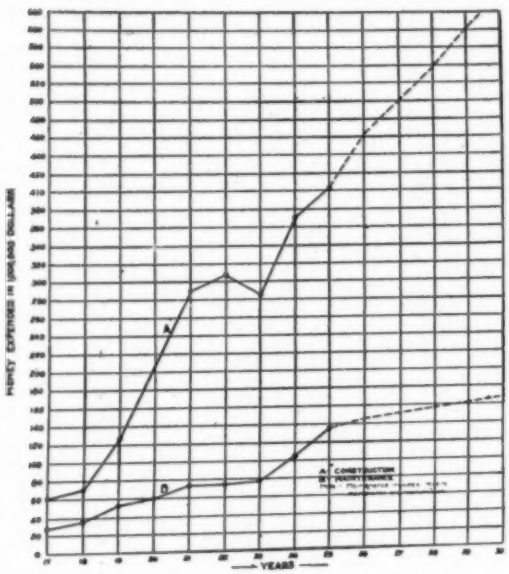


Fig. 4—Chart No. 4, Showing Annual Expenditures for Maintenance and Construction by State Highway Departments.

so far as wheel loads are concerned has reached a point of stabilization.

(2) Rational design methods and improved construction practices have been developed as a result of past experience and highway research. This applies to both new construction and reconstruction.

(3) Maintenance is more adequately organized and roads receive closer and more constant attention. This will serve to decrease the reconstruction periods.

(4) A more accurate knowledge of traffic existing and projected will be very valuable in future road construction and maintenance. A number of the state highway departments have made or have under way comprehensive transport surveys and indications point to a large expansion in this class of investigation.

While this paper does not include a discussion of future construction, Chart No. 3 (Fig. 3) indicates that the trend of annual expenditures for construction per 1,000 motor vehicles is generally upward. It is believed reasonable to expect that this will be true for at least the next five years as indicated.

Having projected the future motor vehicle registration curve on Chart No. 2 (Fig. 2), and the annual expenditures per thousand registration on Chart No. 3 (Fig. 3) as explained, it is possible to compute and plot the estimated future annual expenditures for Maintenance and Construction. This has been shown on Chart No. 4 (Fig. 4) and in percentage increase on Chart No. 1 (Fig. 1).

Future Expenditures of State Highway Departments.—Following are the resulting predictions for the future expenditures by the state highway departments of the United States in the next 5-year period:

(a) For construction a total of about $2,700,000,000, with a maximum annual expenditure of about $620,000,000 in 1930.

(b) For Maintenance and Resurfacing a total of about $782,000,000 with a maximum annual expenditure of about $167,000,000 in 1930.

It may be expected that the new construction curve on Chart No. 4 will at some time in the future assume a downward trend. It will undoubtedly be many years before the peak is reached, considering that only about one-sixth of the total highways of the country have had some type of surfacing. The maintenance curve will always have an upward trend. The statement is frequently made that eventually all highway expenditures will be for maintenance. However, the expenditures for maintenance, for reasons previously given, will never assume the proportions they have for construction. Also about 40 per cent of a new road improvement consists of items that do not depreciate except in relatively small amounts—the road bed and drainage structures. It is true that in a few states maintenance expenditures are already equal to expenditures for construction. This is due, not so much to the fact that the main routes of travel are already improved, but because a large mileage of roads was designed and constructed when the traffic was light in volume and weight.

Relation Between Total and State Expenditures.—Chart No. 5 (Fig. 5) shows graphically the relation between total highway expenditures in the United States and expendi-

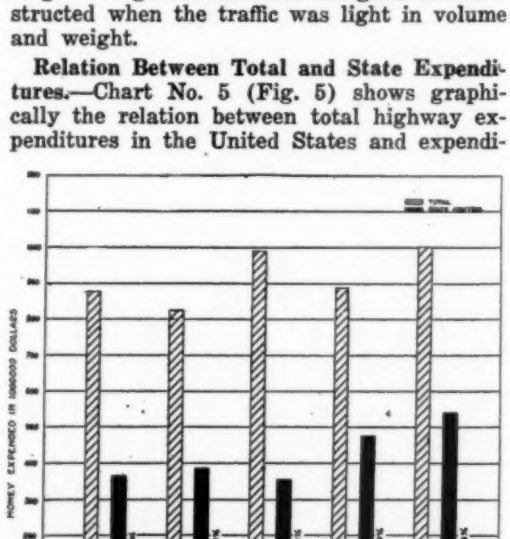


Fig. 5—Chart No. 5, Showing Annual Highway Expenditures, Total—State and Local Control vs. State Control.

tures under state control, and shows that the ratio is roughly 2 to 1. If we assume that this same ratio obtains for maintenance and resurfacing the total expenditures for this class of highway work in the United States for the next five years will be about $1,600,000,000.

The Future Field for the Contractor.—The subject of this discussion is resurfacing and maintenance work as a future field for the contractor. So far all that has been considered is the total maintenance expenditures with no reference to the proportion to be expended by contract.

The writer favors the general principle that the private contract system is preferable to day labor methods for public work projects. The intrusion of government into private enterprise should not be encouraged, and the United States owes much of its greatness to the fact that individual endeavor and initiative have in a large measure been given full range. Centralized control of state highway operations is necessary but the maintenance of a large personnel and the investment of funds in road equipment for work that can be done by contract should be avoided wherever possible. Most highway officials are convinced that day labor operations are not economical. Due to certain psychological factors public labor is not as efficient as private—and no reflection is meant to the many faithful and conscientious employes in public service.

However it is a fact that it is not feasible to carry on many maintenance and repair operations under contract, principally because it is not practicable to formulate definite plans in advance of the work. While it is true that this applies to relative minor operations, in the aggregate they comprise a large share of the total maintenance expenditures. In Ohio the law provides that all highway work, both maintenance and construction, estimated to cost more than $3,000 per mile, must be done by contract. While the Highway Department would prefer that this limit be increased to about $5,000 the law has in general been satisfactory in its operations.

Chart No. 6 (Fig. 6) shows the proportion of maintenance work performed by contract in Ohio since 1917. The percentage varies from a minimum of 6 to a maximum of 26 in 1924.

Using 20 per cent as an estimated average for the entire country the resurfacing and maintenance work to be let by contract in the United States in the next five years will amount to from $300,000,000 to $350,000,000.

In conclusion it should be said that the conclusions presented are a guess which has been derived by rational methods of analysis. The assumptions are believed to be conservative and any errors resulting will be on the safe side. Statistics used were obtained principally from the Bureau of Public Roads, which agency obtained them from the individual state authorities. They are known to be subject to some degree of inaccuracy but not so great as to be inconsistent with the approximate analysis used.

The facts are that large sums of money will be expended by contract for maintenance and resurfacing work on the highways of the United States. As our highway systems are

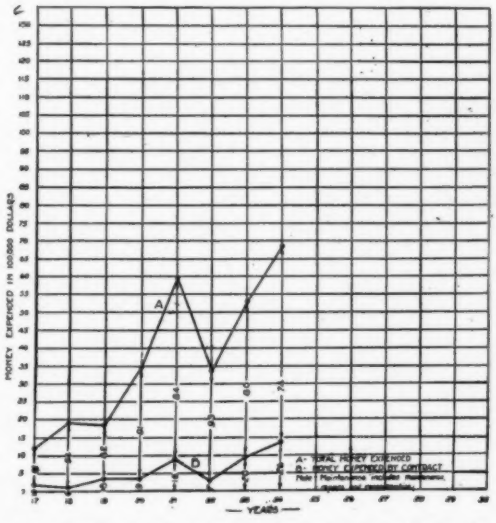


Fig. 6—Chart No. 6, Showing Annual Expenditures for Maintenance by Contract on State Roads of Ohio

gradually completed the amount of new construction will decline while the volume of maintenance necessary will increase until it will become the major operation. The highway officials and engineers who plan and supervise the work, the contractors who carry out those plans, the commercial interests that provide the materials and the mechanical equipment used by the contractors, are all integral part of the great highway industry. All concerned must share in the responsibility for a wise, efficient, and honest expenditure of the funds provided by the public at large.

County Managers.—Much interest has been shown in the plan for a county manager which has been suggested in several states. The governor of Virginia has recommended to the general assembly that they direct their attention to the study of a county manager plan to remedy the lack of financial control and the decentralized county administration.

Experimental Pavements in Queens Borough, New York

Methods of Surfacing Dirt Roads and Constructing Bituminous Macadam and Key Block Pavement Described in Paper Presented before American Society for Municipal Improvements

By E. E. BUTTERFIELD

In Charge of Laboratories, Office of President Queens Borough, New York City

At the 1920 Convention of the American Society for Municipal Improvements I presented a description of a series of experimental pavements planned by Fred H. Shepheard, our engineer of maintenance, and myself, and executed by Mr. Shepheard's maintenance forces. The more conservative members of the society evinced considerable interest in some of the experiments and said, "let us know how these pavements stand up after five years of service." All of the pavements described have now been in service for from five to six years, and one of the experiments has become a standard method of treating dirt roads in the Borough of Queens.

Types and Mileages of Pavements.—The Borough of Queens is the largest borough of the City of New York. The total area of the City of New York is 314.75 square miles, of which the Borough of Queens occupies 117 square miles. The total mileage of streets in the Borough of Queens is between 1,600 and 1,700 miles, of which 529.75 miles were paved up to Jan. 1, 1925. It is difficult to keep track of the exact total mileage on account of the numerous streets cut through each year during a building boom which has been in progress for five years. The mileage of dirt roads is the figure which is uncertain; it is somewhere between 1,000 and 1,200 miles. The pavements, exclusive of the railroad area, are classified as follows:

Type of Pavement	Miles
Sheet asphalt	108.54
Asphaltic concrete	104.72
Bituminous macadam	79.33
Asphalt block	25.02
Granite block on concrete	21.16
Granite block on sand	18.59
Belgian block	2.92
Brick	8.79
Wood block	7.09
Concrete	7.02
Gravel	1.12
Water-bound macadam	145.45
Dirt roads (approximate)	1,200.00
Dirt roads, cinder surfaced and oiled	104.31

Dirt Road Surfacing with Cinders and Asphaltic Oil.—In 1920 Mr. Shepheard and I described a method of treating dirt roads with cinders and asphaltic oil for cold application. Since then we have treated 104.31 miles of dirt roads by this method with extremely satisfactory results. The method is briefly as follows:

The earth road is honed and shaped with a tractor and road machine. The cinders, spread by laborers with coal scoops to an average thickness of 4 to 6 in., are then slightly compacted by a short rolling with a 10-ton roller. Asphaltic oil is next applied cold from a gravity distributer at the rate of ¼ to 1-5 gal. per square yard and the roadway is given a final and thorough rolling with the 10-ton roller.

The treatment is used on cross streets between main arteries and on side streets. The appearance and initial stability are excellent. Under the most unfavorable conditions of a severe winter followed by a spring thaw and rains, with a moderate amount of truck traffic from moving vans and building material trucks, the surface will remain intact for at least one year. Under less severe conditions of weather and little or no trucking traffic some of the dirt roads so treated have required no further treatment in five years. If the surfaces mushes up at the sides and pot holes under the unfavorable weather and traffic conditions it may be easily repaired in the spring at a small fraction of the cost of the initial treatment. The cost of the initial treatment varies from $0.25 to $0.27 per square yard, including all materials and labor.

Bituminous Macadam.—Time was when trap rock was used exclusively for macadam construction in the Borough of Queens. The acquisition of the nearest large trap rock deposits on the Hudson River by the state park commission, forced us to look to other materials for the maintenance of our macadam pavements. In the past six years we have used trap rock, limestone and crushed gravel with apparently the same results under the same conditions of exposure and traffic. Through necessity rather than volition we decided to adopt the working hypothesis that in a bituminous mixture like in a concrete mixture the properties of the resulting mass depended only slightly on the nature of the inert mineral

aggregate. The bond between the mineral aggregate and either the asphaltic cement or portland cement is far weaker than the strength of the mineral aggregate. None of the aggregates used could be called soft or inferior, each type of aggregate having a toughness (impact test) over 8 and a French coefficient of wear (abrasion test) over 8. As our results with limestone have generally been as good as the results with trap rock the only experiment was in the use of crushed gravel and even this has given good results. All of our results on bituminous macadam are based on maintenance work in the upkeep of water-bound macadam pavements according to the following method:

The old macadam roadway was scarified, reshaped, and covered with 1½-in. aggregate sufficient to make the total depth of 1½-in. material 6 ins. after rolling. When crushed stone was used a course of ¾-in. stone was spread on top of the 1½-in. stone. When crushed gravel was used no ¾-in. material was used because the 1½-in. gravel was sufficiently compact and close without the addition of intermediate material. The surface was sprinkled with sand and then rolled. The bituminous macadam binder previously described was then applied at the rate of 1½ to 1¾ gal. per square yard. The surface was then covered with a mixture of material of the same nature corresponding in general grading requirements to broken-stone screenings, 1 cu. yd. of material covering from 24 to 32 yd. of roadway. No seal coat was applied. The bitumen is gradually drawn to the surface by the heat of the sun and capillarity.

It must be noted, however, that our bituminous macadam with either trap rock, limestone or crushed gravel, as mineral aggregate has not stood up under a procession of trucks loaded with building materials. The bituminous macadam pavements in the direct path of extensive building operations have been pretty well pounded to pieces. Under moderate conditions of traffic they have given good service. In a street in which crushed gravel aggregate was used in 1920 there has not been one cent of maintenance expense in six years.

Asphalt Concrete.—The same considerations with regard to the mineral aggregate seem to apply to asphaltic concrete. Owing to the difficulties inherent in the specifications for Topeka mix we do not use Topeka specifications on new work any more, sheet asphalt top and binder course having replaced the Topeka mix entirely on new work. But we still have a large yardage of asphaltic concrete to maintain. In a street paved in 1920 with Topeka mix using crushed gravel from ½-in. downwards as mineral aggregate, there has been no maintenance cost and the only replacements to the surface have been for cuts for house connections.

Key Block Pavement.—This is a freak pavement but one of considerable merit. It consists of:

Alternating courses of wood and granite block laid at right angles to the direction of traffic. The unique feature is an oak block of wedge or key-stone shape, 4x5 ins. on the wearing surface, tapering at the sides to a width which is ½ to 1 in. less at the bottom than that of the wearing surface; the depth is about 4 ins. Courses of granite blocks are first laid with a space of 3½ to 3¾ ins. between the courses. The transverse spaces are then partly filled with sand and the keys are then firmly rammed in between the rows of granite block. The result is a series of alternating courses of granite with oak blocks tightly wedged between them. This type of construction has been used extensively for the past seven years in the franchise area of the New York Railways Co., particularly at street intersections which are subjected to unusually heavy traffic. It is essentially an economical method of repairing or repaving a worn granite-block pavement to meet conditions of excessively heavy traffic. As the oak blocks project slightly above the level of the granite the wood consequently bears the brunt of the traffic and the harder the oak blocks are pounded by traffic the tighter they should become wedged in, thereby increasing the stability of the whole pavement.

In June, 1919, we replaced a badly cobbled Belgian block pavement on a macadam base with the key-block pavement. There was immediate relief from noise and slipperiness and although the pavement has been subjected to heavy crossboro traffic for six years the expense of repairs has been about $100 on three city blocks of pavement on which the only drainage is surface drainage. Some of the oak blocks not coated with asphaltic grout have rotted in six years, blocks still protected by bituminous mastic are in good condition.

White Oak Block Paving.—Owing to the density and toughness of white oak and its low water absorption we have tried untreated oak blocks for repairs to creosoted pine pavement. For repairs they do not seem to offer an advantage. The Borough of Manhattan, however, has laid under contract a stretch on Second Avenue, in which rectangular white oak blocks were used with a seal coat of bituminous grout underneath the blocks and on the surface of the pavement, which is standing up well after three years of service.

It is gratifying to report that all of our experiments have given good service for from five to six years. The cinder and asphaltic oil surfacing of dirt roads has passed the

experimental stage and has become a part of our regular maintenance program. The other experiments have all stood up as well as our regular contract work done under standard specifications. Resurfacing badly worn granite block by means of alternating courses of oak key blocks offers a method of reducing the noise and slipperiness of a pre-existing granite block pavement at a cost about the same as reclipping, renewing and replacing an entire granite block pavement.

Federal Aid Work in Kansas in 1925

The following report summarizes the Federal aid highway work in Kansas in 1925:

Mileage contracted during 1925: 257 miles.

	Miles
Brick	20
Concrete	18
Earth	184
Macadam	6
Gravel	29
Bridges	46

Total contract price of work contracted during 1925, $3,124,716.

Mileage constructed during 1925: 301 miles.

	Miles
Brick	20
Concrete	27
Earth	172
Macadam	25
Gravel	36
Sand-clay	16
Chat	5
Bridges	77

Total cost of construction during 1925 $4,536,809.

Total cost of construction finally accepted during 1925, $5,288,866.

Total Federal Aid agreements signed during 1925, $1,273,435.

Total Federal Aid paid to counties during 1925, $2,405,065.

Total Federal Aid paid to counties Dec. 31, 1925, $14,917,393.

Federal Aid allotment for 1925 (approx.), $2,085,000.

Total Federal Aid allotted to Kansas Dec. 31, 1925, $17,392,245.

Approximate total Federal Aid mileage completed to Dec. 31, 1925:

	Miles
Brick	142
Concrete	449
Macadam	86
Gravel	286
Earth	540
Total mileage	1,503

It will be noted from this report that the Federal Aid work contracted is not as large as might be expected, but in consideration of the fact that the Bureau of Public Roads held up Kansas Federal Aid from Dec. 20, 1924, until Aug. 1, 1925, there was likewise no work contracted between Feb. 1, 1925, and Aug. 1, 1925.

Southwest Road Show and School

Good progress is being made with the preparations for the first annual Southwest road show and school, which is to be held at Wichita, Kan., March 2, 3, 4 and 5. The road show will be under the auspices of the Wichita Tresher and Tractor Club, with offices in the Exposition Bldg., Water and William St., Wichita. The school will be under the direct supervision of the Kansas State Highway Commission with the cooperation of the Federal Highway and Southwest State Highway engineers.

A large amount of exhibit space at the show is reported to have already been assigned to exhibitors, covering practically all classes of road building and construction machinery, equipment, accessories and material. Approximately 25,000 sq. ft. of floor surface of the entire Rose Room of the Exposition Bldg., of the Coliseum, in which the Southwest Road Show and School will be held, has been turned over for Good Road exhibits and the space has been allotted for Government and Southwest States' Road Exhibits. The Bureau of Public Roads will furnish the show and school with an exhibit, which will consist of a full carload. Some of the state surrounding this show, also showed a desire to be represented at the school with a road exhibit. Surrounding the space allotted for the Government exhibit, the following states were allotted space by the Kansas State Highway Commission: Arkansas, Colorado, Iowa, Kansas, Louisiana, Missouri, Nebraska, New Mexico, Oklahoma, Texas and Wyoming. The different State High Commissions have been advised accordingly and have been invited to place an exhibit at this show and also to participate in the program of the good road school.

California Experiments With Adobe Soil

At the California Institute of Technology there has recently been completed a series of preliminary experiments on adobe soil. The purpose of the work was to obtain information regarding the change of volume of adobe as the moisture content varied and also to measure the increase in pressure as moisture content increased. The experiments were conducted by two senior students under the direction of Professor William W. Michael.

The results of the work thus far have not proved wholly conclusive, but certain findings have indicated that further study along the same lines may prove of volue. It is hoped that the work may be carried on during the present year.

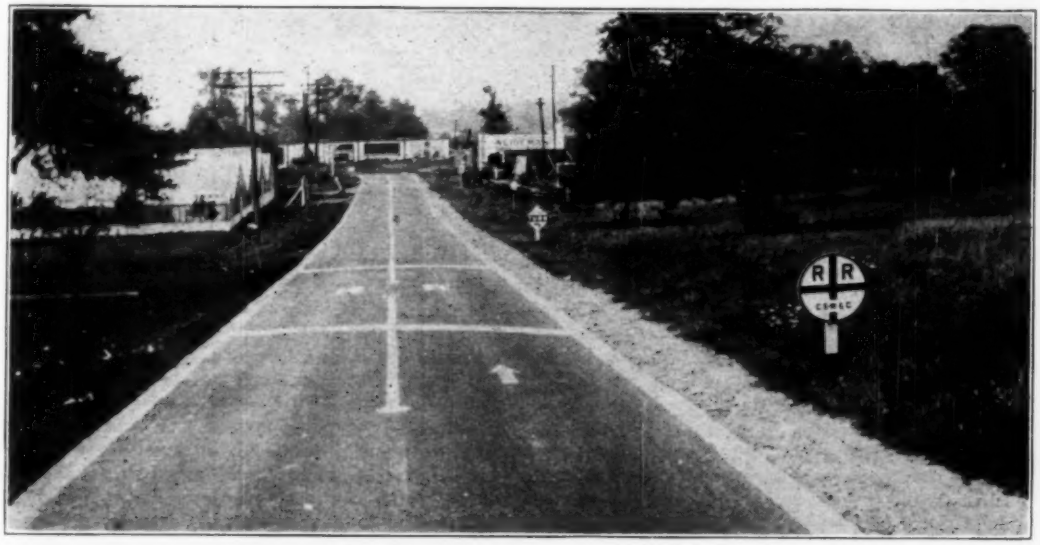
Salvaging Old Macadam Roads

General Economics and Important Features Described in Paper Presented February 16 at 12th Annual Conference on Highway Engineering at University of Michigan

By G. F. SCHLESINGER

Director, Ohio State Department of Highways and Public Works

The subject of "Salvaging Old Macadam Roads" is one that has received frequent and thorough treatment by highway engineers. While it will be difficult to present many new features in this type of road improvement much that has been said will bear repetition. In addition to the general economics of the subject an attempt will be made in this paper to emphasize the importance of certain features of the work not only in connection with the salvaging process but also as they pertain to the design and construction of the flexible types of road pavement used in reconstruction.



Hot Top Surface and Concrete Curb on Road in Lorain County

While it may be true that the subject being discussed is an old one there is no question but that it is one that merits the best thought and efforts of the highway engineer of today. Macadam is the oldest of the modern types of rural pavements. This very fact is one reason that its salvaging is of prime importance as more miles of macadam have had to undergo the effects of the phenomenal increase in motor traffic that has occurred in the last 20 years than of any other type of highway.

The last authentic data in regard to rural roads in the United States are contained in Bulletin No. 1279 of the Department of Agriculture, which show the mileage by types existing Jan. 1, 1922. At that time there were 87,609 miles of macadam (waterbound, surface treated or bituminous), and 25.10 miles of concrete, brick wood block, stone block, sheet asphalt, or bituminous concrete. Without making allowances for the undoubted fact that some of the latter type were constructed on macadam base courses, the data would indicate that at time the ratio of macadam roads to rigid roads was about 3½ to 1. Figures furnished by the U. S. Bureau of Public Roads also indicate that in 1924, 2,464 miles of the macadam type were constructed on the state highway systems of the United States—about one-half the mileage of the concrete type. In Ohio about 45 per cent of the total mileage of paved roads on the state system is of the macadam type. About 170 miles were constructed in 1925.

Economic Life of a Pavement.—The salvage

value of a pavement is the value that can be utilized in the reconstruction of the road. Theoretically a road should be reconstructed when it is more expensive to continue its maintenance than to finance its reconstruction. When this point is reached the pavement is said to have attained its "economic life." The economic life of a pavement can be determined if we have accurate data on its first cost, annual maintenance and salvage value. The question then arises as to the design of the reconstruction project. The problem is similar to that of the selection of the proper type of pavement in the case of original construction, although more intricate. The correct method of determining the relative economy

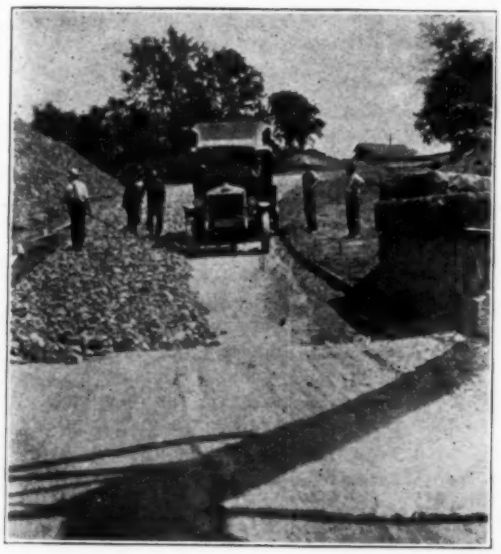
View of Improvement in Ashland County, Showing 15 In. Widened and Elevated Curve; Uniform Grading of Stone.

of pavements is on the basis of annual cost which consists of not only the road cost, including interest on investment, maintenance, and depreciation, but also the cost of operating vehicles over the pavement. This means that in order to reach a definite conclusion, we should have reasonably correct data concerning the amount and character of motor traffic that can be expected to use the road after it is completed.

What a Traffic Census Shows.—Last December we completed in Ohio a comprehensive transport survey of the state road system which included not only a traffic count but also much information as the origin and destination of traffic, character of commodities transported, and weights of tracks and vehicles. This survey was a cooperative project between the Ohio Division of Highways and the U. S. Bureau of Public Roads. I wish to call your attention to one of the conclusions reached as a result of this and similar surveys conducted in other states, namely: the volume of traffic is largely a function of the population tributary to a route. In other words, the road with large centers of population located on it will always receive the largest amount of traffic. Though long distance travel is a small percentage of the whole and is essentially of the passenger car type. In Ohio which is in the direct path of practically all east and west tourist traffic, the quantity of this traffic on our main trunk highways will not average greater than 10 per cent of the total. Mr. Thos. H. McDonald, Chief of the Bureau of Public Roads, in an article discussing the Ohio Transport Survey, said, "Highway traffic is predominantly a short distance movement. This is particularly true of motor trucking, but also generally true of the passenger car movement. Long passenger car trips are quite common, but are small in number as compared with local movement." The Connecticut Transportation Survey indicated that "55.7 per cent of all passenger cars have an average trip mileage of less than twenty miles and 81.1 per cent of the motor trucks travel less than thirty miles per trip." On a road that is important from the standpoint of interstate raffic and possibly has been selected and named by one of the highway promotional associations as one of its transcontinental routes there is frequently a popular clamor for a high type expensive pavement. There are engineers who have maintained that the same type of improvement should be used on all sections of a road although traffic conditions may vary widely on the same route within a few miles. Such types as macadam may be logical on a certain section of a route even if other sections may require brick or concrete. Any arbitrary selection of type of pavement regardless of cost and traffic conditions cannot be justified.

In determining theoretically the most economic type of pavement our computations will be in vain if, due to financial limitations, it will be impossible to construct a section of road long enough to develop the assumed volume of traffic. It is this condition that has caused highway officials to avail themselves of the principle of stage or progressive con-

struction. Centers of traffic flow are connected at once with a type of improvement that is of less permanence than would be called for in the eventual project. The pavement is then added to vertically instead of horizontally as the traffic increases and funds become available. The macadam type lends itself well to this procedure.



View of Improvement of Delaware County Road. Old Traffic Bound Macadam on Right Half of Road; Left Half New Stone Base Course Over New Widening of Old Stone Road. This is Type Where Old Stone Road Is Widened With New Stone Instead of Scarifying and Spreading Old Stone.

Utilization of Existing Macadam.—The manner in which an existing macadam road may be utilized in new construction is comparatively simple. The old metal if sufficiently wide is used as a base course and additional courses are built above it until a pavement of the proper strength is secured. In reconstructing an old macadam road full study should be made of the advisability of sacrificing the old metal for improved alinement and grades conforming to modern traffic requirements. It is also the economic time to widen the pavement and, if good detours are not available the work can usually be carried on half at a time so as to accommodate traffic. All types of pavement, such as waterbound macadam, bituminous macadam, bituminous concrete, cement concrete, and brick, can be used in the resurfacing process. We have used all of the types referred to in Ohio.

The first question that arises in connection with resurfacing an old macadam road is whether to disturb the existing pavement. The advantages in not doing so are that full benefit of the stabilized condition of the old metal is thereby obtained. The risk in this plan lies in the possibility of not getting the widening of the same strength as the existing pavement. In a number of cases we have widened old macadam road successfully with concrete before resurfacing, especially when a high type of top course is used. In widening with narrow strip of macadam it is difficult to get the proper consolidation with a roller for depths greater than 5 or 6 in. Two course macadam widening has been successfully constructed in Ohio by using a loaded truck in rolling the lower base course. When resurfacing with a rigid type it is usually advisable to scarify the old macadam when it requires widening, so as to insure uniformity over the entire width. Many times the surface of an existing road is too smooth to permit of bonding and should be scarified to some extent to remedy the condition. Old macadam roads are usually high crowned and require reshaping by scarifying, although this can frequently be done by the use of wedge shaped courses without disturbing the old metal. The problem is one that requires careful study and at times a complete condition survey, locating in the field the depth and limits of the existing macadam, is justified. The writer did this in one project and found that the time and money spent in a detailed survey and investigation of existing conditions and in the consequent preparations of plans was warranted many times by the resulting economy in construction.

The importance of considering the nature and bearing power of the sub-soil in designing a pavement is now well known to engineers. The value of an old macadam road, even if scarified and spread, as a foundation course that will break up the capillary action of dense impervious clay sub-soils, is obvious. It follows that the design of the reconstruction project should vary in accordance with the condition of the old macadam if we expect to obtain a new pavement of uniform strength at all points.

3-Year Road Building Program in Iowa

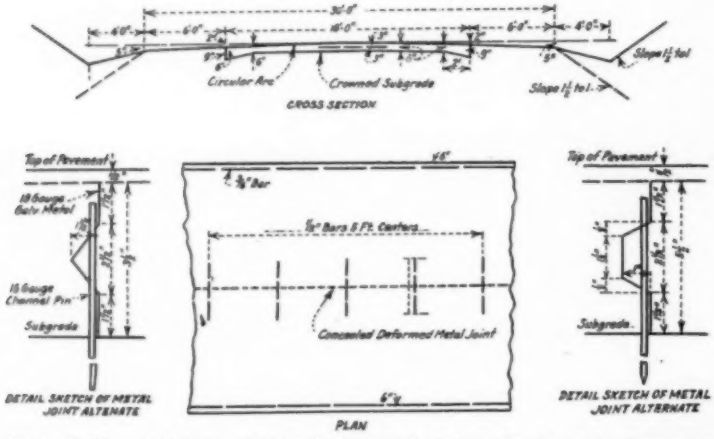
A program of primary road improvement for the years 1926, 1927 and 1928 has been outlined by the State Highway Commission of Iowa. It proposes the drainage, grading and graveling of eight cross state highways east and west and five highways north and south and other sections of the Iowa primary system sufficient to adequately connect every county seat town with the state capitol. The program contemplates the following work, the total estimated cost of which is $27,868,832:

	Miles	Est. Cost
Grading, draining and bridging	1,154	$16,261,502
Graveling	2,732	10,245,330
Paving	46	1,862,000

Concrete Pavements

Standard Designs of Illinois Division of Highways

In our issue of Feb. 3 we printed an interesting article by H. E. Surman, Engineer of Design, State Division of Highways of Illinois, on concrete paving practice. A feature of the article was the discussion of the Illinois standard designs for concrete pavements. The illustrations used in connection with this portion of the article, unfortunately were not as clear as could be desired, and accordingly we have made new cuts which show the details of the design more plainly. We also are reprinting the portion of the article that refers to these cuts.

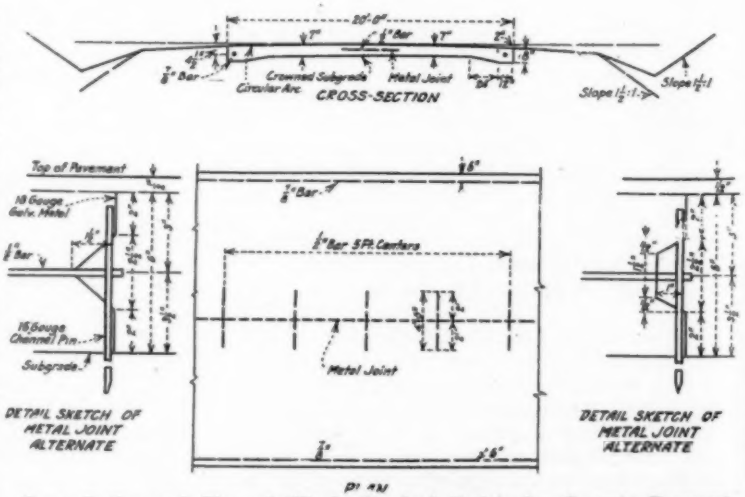


Cross Section and Plan of Illinois Standard Design for Concrete Pavements in Rural Districts and Near Centers of Small Population.

Standard Cross Section. —One of the most outstanding and far reaching developments in concrete paving design is the standard cross section developed from the Bates Road tests, conducted by the Illinois Highway Department during the years 1920 to 1923, inclusive. The main features of this design are the thickened edge with longitudinal steel bars near each outer edge, and a longitudinal dividing plane in the center of the pavement with transverse dowel bars. More than thirty of the states are now either using this design or some modification of it in their present paving practice.

A more recent development of this design is the application of a heavier or thicker pavement near large centers of population. The Illinois practice is to use a 6-in. central thickness with a 9-in. edge thickness for traffic near small cities and rural districts, and a 7-in central thickness and a corresponding increase in edge design for traffic near large centers of population. Pavements near the larger centers also are built to a width of 20 ft. for the initial construction unit, whereas the downstate pavements for the more rural districts are mainly 18 ft. in width. The edge design for the 7-in. center thickness pavement is computed to give a corresponding increase in strength as compared to the edge design used with the 6-in. center thickness pavement. This heavier type of design is not used for the purpose of permitting heavier loads to travel the highway, but as a safety guard for the fatigue in the concrete due to a greater frequency of maximum loads.

Approximately 3,000 miles of concrete pavements have been built in Illinois on the basis of the thickened edge and longitudinal center joint design.



Cross Section and Plan of Illinois Standard Design for Concrete Pavement Near Large Centers of Population.

Michigan Truck Line Highway Maintenance

Organization and Methods and Notes on 1926 Work Outlined in Paper Presented Feb. 18 at Highway Engineering Conference at the University of Michigan

By B. C. TINEY

Maintenance Engineeer, Michigan State Highway Department

The trunk line highways of Michigan represent a capital investment estimated at approximately $100,000,000. The purpose of our trunk line maintenance organization is to protect this large investment, to maintain these roads in such condition that they will render maximum service to the public, and to keep apace with growing traffic demands by occasional betterments to the original construction.

We are, and for several years have been, faced with the necessity of accomplishing this purpose with limited funds. Our maintenance ambitions seem to be about 30 to 40 per cent higher than our ability to finance. By increasing the efficiency of our organization and by using more modern equipment and methods, we will be able to approach nearer to our idea of 100 per cent maintenance, but experience has shown clearly that it will cost about $4,000,000 annually to properly maintain the present 6900 mile trunk line system of Michigan.

It might appear, upon first thought, that owing to the progress of our paving construction program, there should be an annual reduction in the cost of maintenance. This tendency is, at present, far over-balanced by the annual increase in traffic and by an increasingly critical demand, on the part of the public, for more refinement in the work. The motorist demands highway service, and rightfully, because through the gasoline tax, he is paying for that service. When maintenance appropriations are increased to the extent of providing dust layers and adequate resurfacing on all of the gravel roads, and snow removal for wheel traffic on all trunk lines, then the progress of the hard-surface construction program may combat the increase in traffic to the point of showing an annual decrease in maintenance cost.

Proper Supervision of Maintenance Difficult.—The scattered nature of maintenance work makes its proper supervision more difficult than that of construction. While construction operations are usually outlined quite rigidly by specifications, the varying conditions in maintenance work are such that it cannot be as readily covered by specifications, and the maintenance superintendent is compelled to draw on his judgment and experience in many cases.

The maintenance superintendent must be in close touch with his foreman and patrolmen. He must see his roads and traffic often enough to have personal knowledge of conditions and to know how his organization is functioning. Provision should be made for telephone communication between the superintendent and his foremen or patrolmen. Special traffic, such as that of holidays and Sundays, must be anticipated and preparation made to give it service. Bituminous surface treating of gravel and macadam roads should be so scheduled that it will least inconvenience the users of the road. On some of our roads, the traffic is so heavy as to seriously reduce the efficiency of maintenance labor and it is good policy to withdraw the gangs from such sections on Saturdays or other special traffic days.

Winter Work for Maintenance Men.—It is very desirable that as many experienced maintenance men as possible be employed through the winter, as this avoids the trouble and expense of constantly educating new men. The repair of equipment and the increase of snow-removal work is making it possible to offer steady employment to an increasing number of men and thus raise the standard of this labor.

Road maintenance work is always under public observation. In our experience, there is a certain part of the driving public who care little about the methods, organization or cost of the work as long as we give them good results. Others, however, are interested in the efficiency of the labor and equipment used, and they should be given no cause for just criticism. Any employee who is inefficient or who does not use discretion and courtesy in his contact with the public, while on the work, has no place in a maintenance organization. The proper location of headquarters for gangs and patrolmen will eliminate much loss of time in going to and from the work.

A maintenance organization should be sufficiently flexible to take care of necessary work at the proper time and to handle every emergency. The superintendent who does not, for example, patch a section of road until a month or six weeks after it should have been done is inviting a just criticism from the public. Careful thought should be given to scheduling the work so that such delays will be eliminated. It frequently happens that insufficient equipment or lack of experienced foremen to direct additional help prevent the doing of certain work when it should be done. The public, as a general rule sees only the fact that they are required to travel a road which is not receiving proper care.

New Organization in Michigan.—One object of the re-organization of the Michigan State Highway Department this year was to provide more adequate supervision of the maintenance work. In our previous organization the resident engineer had charge of both maintenance and construction in his territory, with the result that maintenance was frequently neglected and the most of his time spent on construction. The new organization provides ten maintenance supervisors, each having charge of maintenance only, with an average of about 700 miles of trunk-line road apiece. The men selected for these positions were, for the most part, those who had shown an interest and ability in maintenance work. The new organization makes possible at least 50 per cent more maintenance supervision than the department had available last year. It is believed that the highway engineer who is specialized on maintenance will give it keener study and accomplish better results than he would if part of his time was spent on construction. We must not lose sight of the fact, however, that a back-ground of construction experience is necessary for the maintenance engineer.

The action of our last legislature, in providing that the construction and maintenance of state trunk lines should be entirely financed by the state instead of the previous cooperative payment plan with counties, will tend toward greater uniformity in the maintenance of these roads. Obviously, a state trunk line road, serving through traffic, should be under central control, and should receive a degree of maintenance justified by the traffic, regardless of county lines.

The township roads, which are at present maintained by small township organizations whose officers are changed frequently, could be more economically maintained by the central county organization. It is believed that future development will tend to eliminate the township maintenance organization and place this work in the hands of the county organization.

The 1926 Maintenance Work.—The state highway commissioner has contracted with 67 counties for the performance of the 1926 maintenance work, while state force-account maintenance organizations will be placed in 15 counties. In one county, the work will be divided between the contract maintenance organizations of two adjacent counties. In many cases, the work of a contract county is not confined to the limits of that county, but is extended into the adjacent county on certain routes, where a continuation of the same type of road, more convenient location of headquarters or other reasons have made such an arrangement seem advisable. This should result in economy and more efficient operation of patrol equipment.

The major materials to be used on trunk line maintenance work this year will be purchased by the state, for contract counties as well as for state organization counties.

Large quantity purchases should result in lower prices than counties would be able to obtain by purchasing individually. All minor materials and some of the major materials which are produced locally will be purchased by the counties.

Method of Maintenance Accounting.—Touching briefly on the method of maintenance accounting; the contract counties will submit semi-monthly statements of pay-rolls, equipment rentals, and material purchases, distributed to the proper classification of work and to the maintenance sections on which the work was done. These statements will be summarized monthly, approved by the maintenance supervisor and forwarded to the Lansing office where they will be audited and paid. Payrolls and material bills in the state organization counties will be paid directly from the Lansing office after being approved by the maintenance supervisors.

The classification of work has been changed somewhat, this year, in order to conform to the recommendations of the American Association of State Highway Officials. It is believed desirable to have a standardized classification of work in the various states, for the purpose of comparing costs. In the new form, dragging and patching will be separated. Snow fence will not be included in snow removal but will be reported under structures. Betterments will be separated from maintenance proper. Under betterments will be included such work as widening the original metal or roadbed, increasing the original thickness of metal, eliminating sharp turns, placing guard rail or culverts where none previously existed, or replacing any structure with a larger structure. Initial bituminous surface treatments of

macadam or gravel roads are regarded as betterments.

A proper office organization is very important in keeping the costs on maintenance work. Information as to the amount spent on each maintenance section should be available at all times to guide the superintendent in making further expenditures from the budget as set up for each section. Accurate costs of the various operations are valuable in making estimates for future work, and the total cost, considered in connection with the traffic census, is used in computing the vehicle-mile cost of maintenance by road types.

Methods on Older Gravel Roads.—Many of our older gravel roads were built under a specification which permitted stone up to 2½ in. in size, and when these surfaces are worn down they are very difficult to maintain. The high crown which was built into the older roads causes the resurfacing gravel to work to the edges under traffic. To correct these faults, the road is scarified to practically its entire depth, the large stone raked out and the remaining gravel reshaped. The equipment generally used for this purpose is a 10-ton caterpillar tractor and a heavy grader with scarifier attachment. It is easier to scarify the entire depth of gravel than to attempt to scarify only a partial depth. After scarifying, the gravel is sometimes harrowed, to further pulverize it and bring the large stones to the top. The stones over 1 inch in size are usually raked out by hand, but one of our counties has developed a mechanical rake which greatly reduces the cost of this work. The over-sized stone should be hauled away and not left long the shoulder where the patrol graders are liable to work them back into the road. After the gravel has been reshaped to proper cross section with the heavy grader, it consolidates quickly under traffic. In fact, traffic is but little inconvenienced by this work, as a section of from ½ to 1 mile may be completed in a day by one outfit. A light resurfacing of clean fine gravel and the application of a dust palliative add an excellent finishing touch to the surface. The cost of scarifying, raking and reshaping is generally from $60 to $100 per mile. The use of this method is increasing in the state, and we regard the heavy tractor, and grader equipment as almost indispensable to the proper maintenance of gravel roads. The investment in equipment is further justified by the use of the tractor for snow removal.

It is probably true that in breaking up the old crust and removing the large stone, the road is rendered less stable during the early spring break-up, but we believe that this is more than off-set by the improved riding quality and greater ease of maintaining the surface during the balance of the year. It is not recommended that a road be scarified late in the fall.

Bituminous Surface Treatments.—Our further experience with bituminous surface treatments on gravel roads indicates that this is a desirable method of serving heavy traffic until such time as pavement construction can be financed. One hundred twenty-two miles of gravel trunk line were maintained in this manner in 1925. In this work we have adhered largely to the method of sweeping, as in the treatment of macadam roads, but will probably try, on a few sections during the coming year, the dragging method which is much used in Wisconsin at this time. We have used cold application materials entirely for the first year treatments and the bulk of our work has been done with tars. Last year we gave one road a second-year treatment with a heavier, hot-application material with very satisfactory results. It would appear that the mat thus produced has sufficient body to be carried for at least two years without re-treating, and at the same time is not so thick that it will wave under traffic.

Melting Ice from Pavements.—A feature of winter maintenance which is increasing in importance in the southern part of the state is the work of relieving the slippery condition of pavements, especially on hills and curves. The methods used have been to melt the ice from the pavement with calcium chloride or cover it with a thin layer of sand. Our experience with calcium chloride would indicate that it is liable to scale a concrete pavement which is of recent construction, but does not seem to effect an older concrete pavement. We have, at times, many miles of road which are in a hazardous condition for traffic due to ice coating, but it seems improbable that we will do more than treat the hills and curves, for some time.

Snow Removal.—During the past three weeks the work of snow-removal for wheel traffic has been extended north to the Straits of Mackinac on four main trunk lines, adding about 700 miles to our snow-removal system. For the first time in the history of the state these roads have been passable for through motor traffic in the winter. The business and social life of these communities has instantly responded to this connection with the open roads to the south. The equipment placed on this work consists of one heavy tractor-plow unit and one light truck-plow unit on each section of approximately 50 miles. We realize that this is not sufficient to give immediate service such as is warranted by traffic in the industrial regions further south. This equipment, however, is operated day and night when necessary, and we will be able to open prac-

tically all of these routes within 24 hours after storms.

Our maintenance supervisors are at present noting the location of drifts with a view to placing snow-fences for next winter, and it will be possible to eliminate much heavy plowing by drift control. The proper location of snow-fences must be studied, from year to year, until the most effective position is found. Recent observation shows that some of our snow-fences are not functioning while others are saving a great deal of money in snow removal. We anticipate that during the next few years the amount of snow-fence used in the state will be increased by many times the present mileage.

Waterbound and Bituminous Macadam

Recent Developments in Ohio Given in Paper Presented February 16 at 12th Annual Conference on Highway Engineering at University of Michigan

By G. F. SCHLESINGER
Director of Ohio State Department of Highways and Public Works

It was formerly considered necessary to use a crown as great as ¼ in. per foot of width on this type of pavement. We are now constructing macadam roads with a crown of 1¾ in. in 18 ft. the same as for concrete or brick. We are also requiring the finished surface of the pavement to so nearly conform to that required on the plans that it will nowhere vary more than ½ in. from a 10 ft. straight edge applied to the surface parallel to the center line or from a templet shaped to the cross section of the pavement. In order to secure better results in macadam construction we have made certain changes in our specifications and practices.

In the case of bituminous macadam (penetration method), we are using bituminous material in the amount of 1 gal. per in. compacted depth applied in three applications instead of two as in former years. For example in a 3 in. bituminous macadam top course we use 1.9 gal. for the first application, 0.8 gal. for the first seal coat, and 0.3 gal. for the final seal coat. Following the application of the first bituminous seal coat the road must be carefully straight edged and any irregularities in the surface not meeting our smoothness requirements must be corrected with bituminous patches. For each of the bituminous seal coats, we require grit to be used at the rate of 1 cu. yd. for each 100 sq. yds. of surface.

Another change made is in our requirements for rolling. We now specify on all waterbound or bituminous macadam construction so many "roller-hours" for each sq. yd. of surface rather than the indefinite description of "thoroughly rolling." At least two rollers are required on each contract on that portion of the pavement which is being penetrated and as many more must be provided as are necessary to give each 100 sq. yds. of surface, not less than 10 hours of actual rolling after the first application of bituminous material. There are occasions, of course, when sub-grade conditions will not permit strict adherence to the roller-hour requirements but generally we have found that we are obtaining more rolling than formerly under the old specifications.

In order to be assured of a depth equal at least to that specified, we are now, in most contracts, requiring a minimum tonnage of stone or slag. We still specify a thickness for each course but state that the contractor shall, if necessary, increase the thickness of the course in order to use the minimum tonnage of stone. It has always been difficult to determine accurately the thickness of a macadam road by field measurements. The use of the tonnage requirement, where it is practicable, eliminates to a large degree the uncertainty as to the quantity of stone necessary to construct a macadam road of given dimensions.

We are requiring all inspectors and engineers to determine that the specified quantity of bituminous materials is being used by computation based on actual measurement of the outage and temperature at the tank car. Other methods usually employed, as keeping record of motor tank loads or freight bill weights result in gross inaccuracies and places a premium on "cheating the job."

In our standard cross-sectional design of the macadam type of pavement we are extending the base course at least 6 in. beyond the top or surface course. This practice strengthens the pavement at the edges where the greatest stresses occur under certain loading conditions, and distributes the edge load on the subgrade. We have found by experience that in the past a large part of our macadam maintenance cost was due to breaking and settlement of the pavement at the edges.

In order to determine whether the contractor has met our smoothness requirements we intend to run over the pavement with a profilometer machine which will record graphically the variations in the surface finish. We have been using this device on concrete pavements and have tried it out for macadam work with the result that by substituting a shoe for the wheel we have devised a profilometer that will record only the profile of the road generally without indicating each individual stone on the surface.

Asphalt Paving Plant Inspection

Desirability of and Important Features Described in Paper Presented October 21 at Fourth Asphalt Paving Conference

By W. J. EMMONS
Highway Research Specialist, U. S. Bureau of Public Roads

The proposition that successful construction depends equally upon adequate specifications and faithful execution surely requires no demonstration. Nevertheless, in the case of asphaltic pavements it is not uncommon to meet public officials and even engineers who feel that the contractor, under nominal supervision, may be safely entrusted with the preparation of the mixture and that the expenditure of a part of the generally limited paving fund for inspection is not justifiable.

Why Inspection Is Essential.—There are several good reasons why competent inspection is essential and should be provided for in the specifications. The contractor is ordinarily a contractor only and not a paving technologist. He is primarily interested in the operation of his plant and in sustained maximum production. He desires quality certainly, but also he is eager to make a profit and his interests are inherently opposed to many of the refinements which are essential to best results. Perhaps the continued existence in some localities of the maintenance clause is in recognition of these facts. If so, it is certainly a less scientific, uneconomic and uncertain method of attempting to insure satisfactory construction.

From the contractor's standpoint the presence of an inspector should be and generally is regarded as welcome assistance rather than as an additional worry added to his burdens. A competent inspector is often able to work out satisfactory combinations of aggregates which individually fail to meet specification requirements thus saving the contractor considerable financial loss. Most important of all, however, is his relief from responsibility for the quality of the mixture which under the inspection plan should be definitely assumed by the engineer.

Rights of Contractor.—In delegating authority to the plant inspector the rights of the contractor to operate his plant and organization in his own way should be clearly recognized. There should be no interference on the part of the engineer's representative in any matter not influencing the quality of the product. He should possess authority to pass upon the suitability of materials, to direct the processes of proportioning and mixing, and to obtain, through the contractor, assignment of laborers competent to perform these latter duties under his immediate supervision. A word of warning is in order, however, lest the contractor, noting the interest of the inspector, attempt to delegate to him for limited periods full charge of the plant. This is going too far in the matter of rendering assistance as it relieves the contractor of responsibilities which only he may properly carry.

Many duties await the inspector upon his arrival at the plant. The plant itself should be examined, with special reference to the proportioning apparatus. Specifications preferably and generally require that all materials shall be weighed but scales sometimes get out of order and result in troublesome variations in proportioning which are very difficult to locate. Consequently both the asphalt and aggregate scales must be checked by means of test weights or sacks of aggregate previously weighed upon any available scale of known accuracy. The bins and screens also should be examined for breaks, mixer paddles for length, and, in general, the inspector should familiarize himself with the condition and operation of the plant.

Approved Sources of Supply.—As there is no time for detailed tests at the paving plant it is necessary that sources of supply be approved before any materials are ordered by the contractor. Then as shipments arrive they should be examined for conformity with the governing specifications. In general, no test other than the penetration test for consistency can be made upon the asphaltic cement at the paving plant. With the consistency ordered to fall within 10-point limits, as is becoming the practice, this test is merely a check upon the grade supplied by the refinery. Should asphalt requiring fluxing be used the test assumes greater importance and becomes a means of determining the proportions of refined asphalt and flux to be used and constitutes an essential check upon the thoroughness of combination. Observation of results over a period of years as well as the results of certain service tests lead to the conviction that the consistency of the asphaltic cement may prove to be a considerably less important factor in the behavior of asphaltic pavements than has been believed. Test pavements of

asphaltic concrete laid and subjected to traffic by the Bureau of Public Roads at the Arlington, Va., outdoor laboratory included satisfactory sections containing asphaltic cements of 45, 55, 65 and 75 penetration, although it is true that those with the hardest asphalt were as a whole more stable. In a series of sheet asphalts laid upon the same location, there proved to be little, if any, difference between the behavior of a section mixed with 31 penetration and another with 55 penetration asphaltic cement.

Sieve analyses for graduation should be made upon the dust, sand and coarse aggregates, and, if possible, this work should be done before shipments are unloaded. It is vitally essential if uniformity of the mixture is to be obtained that aggregates of dissimilar grading characteristics be stocked in clearly defined separate piles. Based upon materials at hand and preferably predicated upon previous laboratory tests a formula for the mixture must at this point be worked out. When this is done the plant may begin operation.

During the period of plant operation the inspector should station himself in such a position that he can watch every detail of proportioning. With most plant arrangements this point of vantage is the mixing platform from which may be observed the weighing of the asphaltic cement and the aggregates, the measurement of dust, the temperature of materials, and the feeding of the cold materials. Periodic sieve tests of the hot aggregates are sometimes required of inspectors and although these are desirable as records, careful preliminary tests from the stock piles should give all necessary working information and eliminate the danger of irregularities which may occur unobserved while the inspector is away from the immediate scene of operations.

Regulation of Bitumen Content.—Asphaltic mixtures are unstable when they carry an excessive amount of bitumen and it is felt that the regulation of the bitumen content is the most important single detail under the control of the inspector. With constant feeding of uniform aggregates variations in weights of asphaltic cement may occur through carelessness on the part of the laborer entrusted with this detail. Variations may also occur at the beginning of the day's work or when, after delays, the asphaltic cement bucket is cold. At such times the bucket may retain sufficient of the weighed amount to cause a decided deficiency in the mixture. Should the weights be adjusted and more asphalt weighed to counteract this tendency, later batches will be rich unless further readjustment is made as the bucket becomes heated.

Improper feeding of cold aggregates, when two or more materials are being combined, will result in a non-uniform mixture. This may prove harmful by unbalancing the aggregate combination but it is believed that the effect upon the bitumen content is even more serious. With the same weight of asphaltic cement greater fineness will result in lean mixtures and a decrease in fine sizes will render the mixture rich. If an asphaltic concrete is being prepared in a single bin plant, particular care must be taken to feed uniformly and accurately all of the materials or variations such as occur with poorly proportioned sands will result to an extreme degree. As an illustration, assume that a mineral aggregate mix consisting of equal parts of stone and sand is being run. The stone will carry possibly 2 per cent bitumen, the sand may arry 10 per cent and the mixture then should carry 6.2 per cent bitumen, the sand may carry 10 per rectly in total amount but irregular feeding has resulted in an aggregate containing 60 per cent stone and 40 per cent sand, the mix should carry 5.3 per cent bitumen. If the batch is actually mixed with the formula percentage of bitumen it would then be rich by 0.9 per cent. It is the presence or absence of such inconsistencies which make the difference between success and failure.

Batches of aggregate showing lack of uniformity should be discarded without hesitation as should also those to which an excess of bitumen has been added. The old practice of throwing in an additional quantity of dust to compensate for excess bitumen is dangerous and should not be permitted.

The Pat Test.—Until a laboratory test properly correlated with service behavior of mixtures is devised no method better than application of the familiar pat test can be suggested to determine when the proper amount of asphaltic cement is present in sheet asphalt mixtures. This simple test has its weaknesses but can be made quickly and in the hands of an experienced man may be depended upon to maintain a uniform mixture. It is believed that the stain should be very light, particularly if heavy traffic is to be borne by the pavement. The pat test is, of course, not applicable to asphaltic concretes and maintenance of a fixed percentage of asphalt in types containing coarse aggregate is only possible through trained visual inspection.

Recently there has been a tendency to permit considerably higher temperatures of mixing than was formerly the case. It is probably true that in this manner a more uniform distribution can be obtained, particularly with the leaner and higher filler mixtures which are now being advocated. It is likely that the asphaltic cement is hardened to a certain de-

gree and this, of course, may be harmful if extreme temperatures or if asphaltic cements of great susceptibility are employed. The extent of hardening with a given asphaltic cement cannot be accurately determined at the present time, as a satisfactory method of recovering asphalt from pavement mixtures has not been devised. Observation has indicated that 375° F. is very likely a safe temperature for sheet asphalt. Quite a different condition holds with asphaltic concrete, as it is desirable for the stone to carry a coating of the sand mortar when it leaves the plant. This condition somewhat counteracts the tendency toward segregation of the coarse particles in raking on the street and thus results in greater uniformity of construction. At temperatures around 325° F. the sand mortar tends to leave the surface of the stone and consequently it would appear preferable to use this figure as a maximum working limit.

The Association of Asphalt Paving Technologists

A new technical organization, bearing the above title, met Jan. 14, 1926, at Hotel La Salle, at Chicago. The constitution and by-laws were adopted, officers were elected and committees were appointed. Forty members were present.

In January, 1924, a small group met in Chicago informally for the purpose of discussing such an organization. In January, 1925, a considerably larger group met in Chicago and definitely organized. Francis P. Smith, of Dow & Smith, consulting engineers, New York City, served as chairman of the first meeting. Hugh W. Skidmore, of the Chicago Paving Laboratory, Inc., Chicago, Ill., was chairman of the 1925 meeting, and Chas. A. Mullen, of the Milton Hersey Co., Ltd., of Montreal, acted as secretary of both meetings. Roy M. Green, of the Western Laboratories, Lincoln, Neb., was chairman of the committee which drafted the constitution and by-laws.

Are association will collect and distribute technical data pertaining to asphalt paving, encourage and conduct co-operative research work, and will serve as a clearing house of ideas presented by its members. The officers for the present year are:

President, Hugh W. Skidmore, president Chicago Paving Laboratory, Inc., Chicago, Ill.; first vice president, Leroy M. Law, chief chemist, New Orleans Refining Co., New Orleans, La.; second vice president, W. J. Emmons, highway research specialist, U. S. Bureau of Public Roads, Washington, D. C.; secretary-treasurer, Chas. A. Mullen, director Paving Dept., Milton Hersey Co., Montreal, Que., Canada; chairman general research committee, Prevost Hubbard, chemical engineer, The Asphalt Ass'n., New York, N. Y.; chairman, committee on voids in aggregates W. J. Emmons, U. S. Bureau of Public Roads; chairman, committee on street operations, W. L. Hempelmann, engineer, The Texas Co., Asphalt Dept., Chicago, Ill.

Tree Watering Outfit

The headquarters shop of the California State Highway Commission during the past summer equipped two standard tank trucks with 1-man tree watering attachments. Fig. 1 shows the outfit in position for traveling, the pipe being swung back against the truck and latched into place so it will retain its position during transit.

Figure 2 shows the pipe swung at a right angle to the truck and in position for tree watering. To keep this pipe from swinging back while the truck is in motion between the trees, a short piece of rope is fastened to the end of the pipe and to a convenient point on the driver's seat.

The trucks were equipped with acetylene lights mounted crosswise to the truck on the driver's seat. The tree watering is done at night, hence the need for the lights.

Fig. 1—Outfit in Position for Traveling

Fig. 2—Outfit Ready for Watering Roadside Trees

Road and Trail Construction in the National Forests

By G. H. LAUTZ
Assistant Chief Engineer, U. S. Forest Service

From the year 1912, when federal funds were first made available for the construction of forest roads and trails, to June 30 of this year there had been expended a total of $56,891,914. Of this amount $43,013,056 was obtained from special appropriations made by congress for the construction of forest roads and trails, $12,740,135 was obtained from state and county co-operators and the remaining $1,138,723 was secured from other federal funds. This total expenditure has accomplished the construction of 10,022 miles of roads, 21,497 miles of trails, and the maintenance of 13,978 miles of roadway and 38,858 miles of trails.

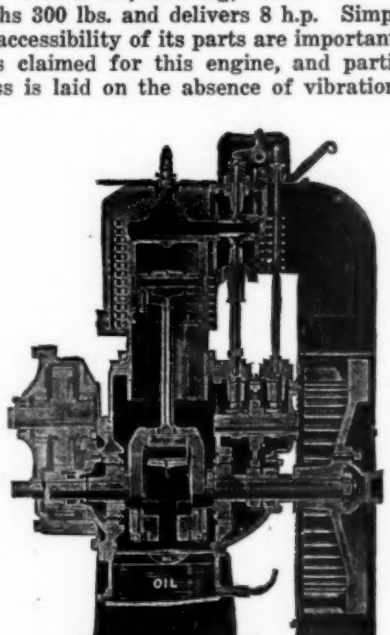
The work thus far accomplished consists of 3,154 miles of so-called major roads which have been constructed under the direct supervision of the bureau of Public Roads. These have cost $36,731,801, an average of $11,645 per mile. This average varied from a cost of $3,726 per mile of roadway as constructed in Florida to $25,062 per mile as constructed in California. The minor roads constructed by the local Forest Service personnel cost $8,440,179. This accomplished the construction and betterment of 6,868 miles of roads at an average cost of $1,229 per mile. For the combined major and minor roads, the average cost was $4,507. During these same years 21,497 miles of trails were constructed and improved by the Forest Service for $4,499,329, which represents an average cost of $209 per mile.

From studies made by the districts it is estimated that there will be required for the completion of a comprehensive road and trail system for all the National Forests the construction of an additional 11,112 miles of roads and 22,682 miles of trails and the reconstruction and improvement of 22,127 miles of existing roads and the reconstruction and improvement of 11,729 miles of existing trails. This work, it is estimated, will cost approximately $186,186,624 for roads and $6,600,500 for trails.

During the past fiscal year there was accomplished the construction of 1,800 miles of roads and 4,085 miles of trails and the maintenance of 10,867 miles of roadway and 32,686 miles of trails. This represented an expenditure during the year of $12,834,738, of which $2,291,325 was co-operation as secured from state and county authorities. The largest mileage of roadway constructed during the past fiscal year was completed in Oregon—237 miles. California was a close second with 235 miles. Colorado constructed and improved the maximum mileage of trails—this being 829 miles—while Idaho followed with the construction and betterment of 508 miles.

New Air Cooled Engine

A new air cooled engine for powering labor saving outfits such as generator units, hoists, mixers, etc., has been produced by the "New Way" Motor Co., Lansing, Mich. The engine weighs 300 lbs. and delivers 8 h.p. Simplicity and accessibility of its parts are important features claimed for this engine, and particular stress is laid on the absence of vibration, the



Sectional View of Engine

engines' close governing and smooth running. The unit construction is stated to permit removing the crankshaft without disturbing the ignition or governor, valves or gears which are so assembled that one or all can be detached and replaced rapidly. The connecting rod bearing can be adjusted in 5 minutes. Large oversize roller bearings are used for the crankshaft. Lubrication is of the automobile principle of a gear driven force feed pump in combination with splash. A power take-off can be applied giving a half speed drive which can be operated in any position within a 4 11-16 in. radius, making it adaptable to a wide range of machines without any changes in construction.

Maintenance of Gravel Streets in Small Indiana City

Method of Oiling in Small Indiana City Described in Paper Presented Jan. 22 at Twelfth Annual Road School, Purdue University

By E. D. CANATSEY
City Engineer, Martinsville, Ind.

The maintenance of gravel streets embodies a number of elements and conditions not encountered in the regular maintenance routine on county and state gravel roads.

The greatest difference is due to the use of road oil on streets. Instead of a thin carpet of loose gravel to work with the ordinary maintenance tools, we have a smooth hard surface, and instead of the wash-board surface to contend with, in dry, hot weather, the oiled streets break in small round, basin shaped holes, that quickly grow larger and more numerous, we call them pot holes. This evil is by far the most difficult problem to overcome.

Preparatory Work.—But to begin at the beginning, I think we should start in mid-winter. This is the proper time to begin preparing the streets for oil. We will assume that the roadbed and curb ditches have been properly constructed and maintained. While the streets are frozen solid, is the best time to apply a very thin layer of good gravel. Apply it over the sections that show weakness of surface; that is where the pot holes form in great number. This gravel should have a minimum of sand, but should all pass a 1 in. screen, or better still the ¾ in. screen. By trial of different seasons of the year for adding new metal to the oiled surfaces, I believe best results are obtained by applying when the road is frozen. The metal added at this time seems to stick where applied, and as the frost leaves the roadbed the new gravel bonds and keys itself into the old surface. The use of the drag, during the freezing and thawing weather,—over surfaces thus treated, will obliterate the pot-holes.

As the oiling season approaches we must begin the final preparation for the application of the oil.

Application of Oil.—Usually in the latter part of May, after the heavy spring rains we apply the oil,—but the streets should be in first class condition before the oil is applied. A light scarifying is best at this time.

Formerly in Martinsville this was done with a specially constructed street harrow. This tool will scarify an inch or two of the old oiled surface; then with a grader a uniform surface can be made.

The oil should not be applied when the ground is too cold or when there is much dust. The light scarifying allows the hot oil to penetrate deeper and faster than otherwise.

We apply the oil with a pressure tank distributor which has an inside burner, the temperature of the oil, while being applied runs from 130 to 180 deg. F. Steam is applied to the tank car about six hours before the oil is pumped into the distributing tank.

We usually oil every other street, say east and west, then every other street north and south. About a week or ten days later the remaining streets are oiled. This allows traffic to avoid the freshly oiled streets to a certain extent.

Sanding Oiled Street.—An experiment was tried two years ago on four blocks where traffic was heaviest. Following the oil tank, torpedo sand (i. e. sand that passed the ¼ in. and was retained on a ⅛ in. screen) was spread on the hot oil, just enough to kill the flow and thicken the oil on the surface. This required about 10 cu. yd. per block,—the street being 40 ft. wide. This showed good results, the oil was not tracked away much and a surface was obtained that was smooth and lasted well. This torpedo sand is obtained from a local gravel plant and is a bi-product made in getting out concrete material for the state.

New gravel streets usually take oil nicely the second year and can be easily maintained. With the older streets it is a different proposition. In Martinsville the oil used always runs from 50 per cent to 70 per cent asphalt and lasts on the surface from year to year.

Treating Pot Holes.—With the hot, dry weather, and heavy traffic, the aforesaid pot-holes begin to show in all city gravel streets. It is useless to attempt to fill these holes with fresh gravel. This seems to accelerate the grinding out of the holes.

Light scarifying is necessary. The street harrow and horse-drawn grader is too slow and expensive. The power grader with scarifier attached is a very successful tool.

The machine has a 10-ft. blade and the scarifier is just ahead of the blade. To do light scarifying leave all eight of the teeth in, if deep scarifying is required use only four teeth. The idea in scarifying the oiled street is to get enough of the oiled gravel to fill the holes. After the scarifying, the blade is set at a slight angle to cast the material from the center. You will be surprised at the amount of black material the blade will gather, after the light scarifying. This material will stay in the holes. The reason for setting the blade to cast outward is to flatten the crown. Most of our streets have too much crown.

The great advantage of the one-man power grader can easily be seen. When scarifying or grading he can stop at any time and back up as many times as necessary to fix a particularly bad spot in the street.

By careful handling, the streets can be lightly planed over with the blade and enough material carried along to fill all depressions; but, it is impossible to try to cut very much without the danger of rolling up the entire oiled mat and spoiling the surface of the street.

Smoothing Out Rough Surfaces.—When a street becomes extremely rough, it is always best to scarify the oiled surface thoroughly, then level up with the blade. The surface in such cases should be scarified as deep as the bottom of the deepest holes. The 1800 lb. dual wheels roll the surface down pretty well and the street soon looks as black as before.

When planing the streets lightly to keep small holes filled, I prefer working from the center toward the edges, then if any excess material is left, work this back to the quarters; this is the section that usually gets most of the wire and breaks first.

Sometimes we have sections of streets that need re-forming entirely; in the case I have in mind, the street was arched up in the middle of the block, or at the alley, about 18 in. too high; we scarified the gravel about 6 in. deep, then with the blade this was graded to the curb in a narrow ridge. This operation was repeated over and over until all of the gravel was transferred to the curbs. Then the sub-grade was scarified and ridged with the blade in the center of the street until the proper grade for the sub-grade was reached. This loose material at the center was hauled away and the gravel was replaced with the power grader in even layers. When the job was completed the street was rolled down and smoothed by the big dual wheels of the grader. In this special case the gravel was removed from one block of street; about 60 cu. yd. of sub-grade material was removed and the gravel replaced in 15 hours. The force employed was one man with power grader, two teams, and two extra men.

This piece of street was oiled about two weeks later, and the oil went in, in good shape; this street stayed in good shape throughout the summer.

The Value of Street Oiling.—There are two points to be mentioned on this subject that prove the value of street oiling, aside from the feature of preventing dust.

The first is the saving in the wear on the surface. Two years ago we left gaps about 6 ft. wide across the streets at sidewalk crossings, unoiled. This was to give pedestrians a place to cross without walking in the fresh oil. These unoiled strips in some cases wore down as much as 4 in. lower than the oiled section adjoining. This gives some idea of the amount of road metal saved on our 22 miles of graveled streets in one year.

The other point is in the matter of water saved. Just before oiling, in late spring, water is used in great quantities by people living on graveled streets, to keep down dust. The water superintendent's daily pumpage report shows a marked difference in water used before and after oiling.

Either of these two points show enough gained to prove oiling worth while.

Summing up the subject of maintaining oiled gravel streets we must bear in mind that in maintaining these streets we must not destroy the effects of the oiling, hence we must maintain with the oiled gravel which varies in thickness from 1½ in. to 4 in.

Scarify lightly as often as necessary and plane the surface often with a heave type power grader of long wheel base.

New Officials of Massachusetts Highway Association

The annual meeting of the Massachusetts Highway Association was held Feb. 11 at Boston, 80 members being in attendance. Announcement of officers was made naming the following as result of a letter ballot for election of officers of the Association for the ensuing year: President Fred B. Richardson, Deputy Superintendent of Streets, Brookline; Vice-President, Pehr G. Holmes, Ex-Mayor of Worcester; Treasurer, Chas. A. Brown, Wellesley; Secretary, John M. McCarty; Directors, Franklin C. Pillsbury, Project Engineer, and Arthur E. Blackman, Superintendent of Public Works at Plymouth. William E. McClintock, organizer and first President of the Massachusetts Highway Association and former member of the State Highway Commission was elected an Honorary Member.

Removing Traffic Obstacles

Methods Followed by Highway Authorities Described in Paper Presented Jan. 22 at Twelfth Annual Road School, Purdue University

By HOWARD OLSON
Engineer, Chicago Regio nal Planning Association

The term traffic obstacle in general usage is not limited in its meaning or very definite. In this discussion we will say that any regulation, any regulatory device or any physical feature existing in or along a street or highway that prevents or reduces the economical free or safe operation of motor vehicles is a traffic obstacle.

The Committee of Highways of the Chicago Regional Planning Association includes highway officials of the federal government and states, counties and cities of the region. To that group of men, who direct the construction of many million dollars worth of roads each year, removing traffic obstacles is a most important service to the people of the region. It was for that reason that they inaugurated a series of traffic obstacle surveys to be made on the main traveled highways leading out of the City of Chicago to be followed by a campaign pointing out the defects and urging their removal.

Traffic Obstacle Surveys.—Each survey is started at the loop district of Chicago and is carried outward, through the many suburban towns and into the country for a distance of at least 50 miles. From beginning to end roadway widths are recorded and logged along with bottle necks, sharp jogs and turns, rough pavements, unpaved car tracks, railroad grade crossings, narrow bridges and subways, dangerous sections of the road and any other conditions which slow down or stop traffic or increase the cost of traveling over it. From the notes taken the observer makes sketches of the more important obstacles and shows or describes means of improving each. Strip maps are also drawn showing diagrammatically the variation in width of the roadway, the location of the obstacles and the jurisdictions having control over them. The survey is then reviewed by the members of the committee, many of whom are familiar with local conditions along various parts of the route, and the procedure outlined to bring about the improvement of each obstacle. Meetings are arranged with the local authorities having jurisdiction over each section at which ways and means for effecting the work is decided upon. In every instance the many local officials, good road committees, commercial clubs and newspapers realize the value of the work and give their fullest co-operation in carrying out the details.

What the Surveys Show.—The experience of these surveys very often show that the fullest use of our investment in street and highway width is not realized due to different standards or lack of standards used in the various jurisdictions or, absence of a comprehensive plan for the entire route. The most striking example of such a condition exists on the Dixie Highway route extending south out of Chicago. On this heavily traveled thoroughfare a 6 mile stretch of 70 ft. pavement is bottled up with a 40 ft. wide throat at each end. It is easy to see that 30 feet of the 70 ft. wide pavement gets very little travel. Plans are now under way, however, to remedy the condition.

The obstacles that exist on the more important highways of the region and the congestion resulting on days of heaviest travel is almost unbelievable to anyone not having had the experience of being a part of that congestion. One mile an hour is often the average rate of speed. Typical of these highways and the conditions found on them is Indiana's state road number 43, called the Dunes Highway, which runs through Hammond, Whiting, East Chicago, and Gary around the lower end of the Lake to Michigan City. Any summer holiday or Sunday will see this popular road filled with unbroken lines of motor cars extending from the Illinois state line on the west to Michigan City on the east. So close are they, at times it is said, that when a highway policeman in Michigan City holds up his hand for traffic to stop, motorist 35 miles westward shove on their brakes and come to a standstill.

The cause for the congestion on this particular road is due to the interference caused by the following obstacles recorded in the survey recently made over it: shoulders of loose sand along along the country section of the pavement too soft to support cars forced to stop on account of tire or engine trouble; 18 railroad grade crossings in the towns along the route; worn-out, bumpy pavement, sharp turns and corners; a large ornamental square that forces all cars to slow down to twist around its corners; an improperly timed stop-and-go traffic signal; street cars that cut down the width of the roadway; and, unpaved street

car tracks. Each obstacle along this route plays its part in adding to the delay and collects its tax in increased operating cost. If usable shoulders were constructed along the country section of the pavement it would be improbable that congestion would be materially relieved. The biggest part of the delay is due to the obstacles existing in the towns along the route.

On other main traveled roads of the region the same general conditions is also true. The causes of congestion lie at the gateways and in the towns instead of on the country highway. It is interesting to note how the location of traffic obstacles have changed since the invention of the motor car. Everyone can remember how the motorist heaved a sigh of relief when his automobile pulled itself out of the rural mud and bumped onto the city pavement. But now it is different. The sigh is of regret as he leaves the smooth country highway and strikes a narrow worn-out city street and is confronted with slow-moving local traffic, numerous traffic regulations and unregulated stop-and-go signals.

Through Traffic Roads.—The examples mentioned above go to prove why it is good highway engineering and business to locate main highways around towns and cities and build adequate connections to the business centers. It is only recently that municipalities demanded of state highway commissioners and county highway departments that paved roads be focused in to their business centers. The pendulum of public opinion, however, is now swinging in the other direction. Business men question the value received from through-traffic trade, but are unanimous in their opinion that anything that adds to the ever increasing local traffic congestion is harmful to their business. To build highways around built up centers is exercising good foresight. Roads must be built to fit modern demands. The automobile which is being designed for faster speeds every year and which is increasing in numbers at an enormous rate, is now the ruling factor in highway location, design, construction and regulation.

Traffic Obstacles That Should Be Removed.—In the interest of safety, economy and free movement of motor vehicles, the following conditions, classed as traffic obstacles, should be removed as soon as possible from existing highways and avoided in the building of new ones.

Local business districts or built up centers where traffic concentrates.

Jogs in alignment due to correction lines or other causes.

Blind curves, intersections and grade crossings, standardized warning signs and signals effectively placed to serve under the most adverse conditions lessen the danger at these points.

Sharp curves not properly banked and widened.

Curved approaches to subways or underpasses, viaducts, and bridges.

Railroad grade crossings. Until funds are available to eliminate grade crossings on the main highways, crossing planks should be maintained flush with the rails and approaching roadways.

Car line streets. Street cars back up and stop traffic and their roadway pavements are seldom in good condition.

Rough worn-out pavements.

Bottle necks due to narrow roadways, bridges, viaducts, curves and subways or underpasses.

Short vertical curves on summits of hills.

Steep grades.

Highcrowns on roadways.

Slippery road surfaces.

Narrow or unusable road shoulders.

Sign, signal or light posts and buttons located in the center of intersections. They should be placed on the intersection roadway centerlines at the edge of the intersection.

Stop-and-go traffic signals improperly timed for traffic.

Intersections with stop signs in all directions.

Roadways lacking painted centerlines or traffic lanes.

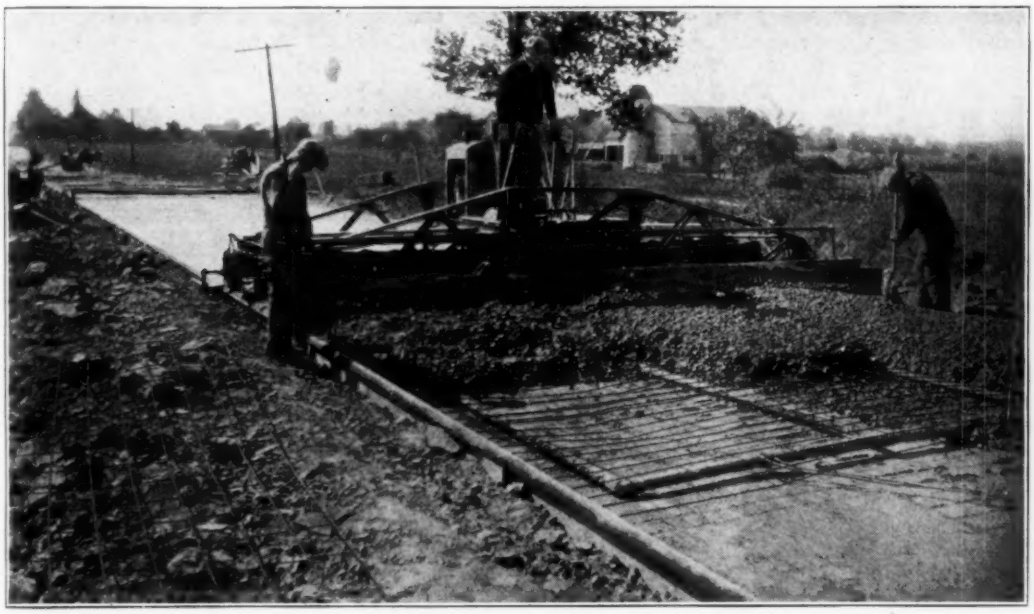
Unstandardized signs, signals and regulations. The Hoover Conference on Street and Highway Safety made up of representatives from the entire country has made great progress in this direction.

Route, warning and street signs ineffectively placed, out of range of driving lights, not illuminated or invisible at night. With the rapid increase in numbers of motor cars throughout the country, traffic regulations and control is becoming more necessary and exacting. Signs and signals are the means for making regulations and control possible, provided, they are so placed to be effective under the most adverse conditions—darkness and a wet or icy pavement. To test the value of a sign system drive under the conditions mentioned above and see if all signs are easily visible and all stops can be complied with without skidding past the point of danger.

Street Traffic Survey for Chicago.—The Association of Commerce of Chicago has financed a $50,000 street traffic survey for the city. The services of a traffic engineer, the expert who installed the system now being used in Los Angeles, has been obtained by the association.

New Concrete Road Finishing Machine

At the recent Road Show at Chicago The Lakewood Engineering Co., Cleveland, O., exhibited for the first time its new 1926 model type "C" Lakewood road finishing machine. Briefly, the machine combines a screed and tamper. At the front is the screed, or strike-off, which is of steel, adjustable for crown, and 12 in. wide on the bottom. It is driven from 35 to 40 strokes per minute and spreads and surfaces the concrete. The tamping member, which is hung on springs behind the screed, or strike-off, has a quick, snappy up and down movement. At the rear of the machine is the belt float with a very much improved driving mechanism. An automotive type of sliding gear transmission with two speeds forward and two speeds reverse is employed. Cut gears of high carbon steel heat treated are carried on alloy steel shafts which in turn are mounted on Timken roller bearings. The transmission is enclosed in an oil tight housing and gears run constantly in oil, which insures ample lubrication at all times. Larger traction wheels, 14 in. in diameter, are used which are mounted on square shafts, eliminating the necessity of keys. By simplification of side truck construction, no chains or traction gearing is required, the drive to each wheel being direct from enclosed worms and gears mounted on the transmission frame. A stronger truss of channel frame construction is used, the central panel of which carries the complete transmission assembly. This central panel is identical for all widths of machines so that to change the width it is simply necessary to bolt on the new extension side members of the proper width and put in place the other cross members such as the screed and tamper. The machine is driven by a Le Roi 2-cylinder radiator cooled engine. The sequence of operations with the finisher provides first for screeding and tamping, then a second screeding and tamping, and lastly the use of the screed and belt, eliminating for the final operation the use of the tamper. In other words, the final operation is a smoothing to obtain an easy riding surface free from waves.



New 1926 Model Type C Lakewood Road Finishing Machine.

Proposed International Highway.—Increased activity in Mexico, Panama, and South America was shown by reports of delegates from these countries at the recent Good Roads convention at Chicago. The plans for an international highway extending from points in Canada to Colombia in South America, were discussed, and its completion predicted in a few years. A report on the progress along the highway route will take place at a special Pan-American session to be held during the 1927 convention of the American Road Builders Association.

Regional Planning

Extract from Paper Presented Jan. 22 at 12th Annual Road School, Purdue University

By HOWARD OLSON
Engineer, Chicago Regional Planning Association.

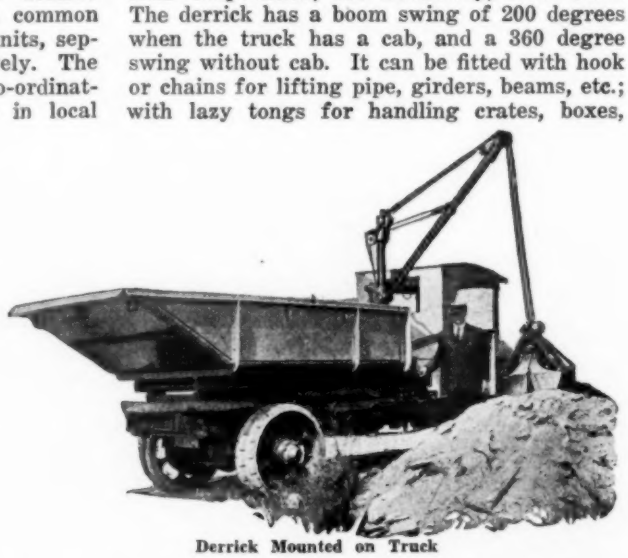
There is nothing complicated or involved in the regional planning idea. It is merely a simple answer to a difficult problem that arises wherever similar or related work extends across political boundary lines. The condition that gave rise to the Chicago Regional Planning Association is the same that caused state highway commission to be formed throughout our country, namely, a common problem too big for small political units, separated as they are, to handle effectively. The result desired was also the same: a co-ordinating influence to bring about unity in local plan and work with greater vision for future needs. The principle underlying the Chicago Regional Planning Association is a departure from that usually followed in metropolitan planning. It recognizes all officials whose specified duties are related to the work involved. It also included public spirited citizens whose special knowledge or interest will be of value. These men are made consultants and directors of the planning and what special staff is required, work under their policies. The final result is that all phases of the plan receive immediate public support and are assured of realization.

Although the Chicago Regional Planning Association is concerned with all problems bearing upon community development, such as, water supply, sanitation, rail, water and air transportation, parks and forest preserves and others, the most important and urgent is highway transportation. The common problem confronting the highway authorities in the many counties and towns grouped around the lower end of Lake Michigan, can be divided into two parts: one, transforming their old-horse-and-buggy age roads and streets into good efficient and safe carriers of motor vehicle traffic; and, two, planning every new road for modern automobile traffic with extra width for future widening.

The problem, of course, is at present more intense near the cities of Chicago, Hammond, and Gary and is likewise near all large populated centers. It does not differ, however, from that which exists in every town in Indiana, Illinois, Ohio, or any other state. Motor transportation is just in its beginning. What is now true around our larger cities will soon be true in our smaller towns. The disease that blights the highways around our larger towns is now, farther out in the country, in its first stages. But, if the highway officials will prescribe the right kind of treatment now, doctor bills and surgical operations on their respective highways will not be half as expensive later.

Motor Truck Derrick

A many purpose derrick designed for mounting on a truck chassis is a product of the Atia Corporation, 150 Broadway, New York. The derrick has a boom swing of 200 degrees when the truck has a cab, and a 360 degree swing without cab. It can be fitted with hook or chains for lifting pipe, girders, beams, etc.; with lazy tongs for handling crates, boxes, etc; or with clamshell or orange peel bucket. The derrick is operated entirely by one man with single lever control. The boom is elevated by worm and hand crank, conveniently located, to any angle from horizontal to vertical. Boom swings in either direction by power. No hand slewing. Operator always stands on street directly facing job. The derrick is made in two sizes as follows:



Derrick Mounted on Truck

Weight, 1200 lbs. Capacity 1000 lbs.; with braces, 1500 lbs. Column height, 9 ft. Boom length, 9 ft. Radius of boom swing, 16 ft. Lift from street, 12 ft. Speed, 60 ft. per minute. Length of cable, single drum, 60 ft.; double drum, 30 ft. Uses orange peel sewer bucket or clam shell bucket up to 4 cu. ft.

Weight 2500 lbs. Capacity 3000 lbs. Column height, lowered, 7 ft.; raised, 10 ft. Boom length, closed, 11 ft.; extended, 18 ft. Radius of boom, 34 ft. Lift from street, 20 ft. Speed, 60 ft. per minute. Length of cable, single drum, 60 ft.; Uses orange peel or clam shell bucket up to 1-2 cu yd. capacity.

A. R. B. A. Essay Contest

First Prize Awarded to Student at University of Wisconsin

George F. Gerling, a student at the University of Wisconsin was the winner of the International College Essay Contest conducted by the American Road Builders' Association at its recent convention at Chicago. The winner was awarded a prize of $250 toward the pursuit of a college education. Other winners were John Luby, Massachusetts Institute of Technology; Alfred Carter, Oregon Agricultural College; George Goodrich Ree, Albion College; and M. H. Salema, Chicago Art College.

The wide public interest in the essay contest, the subject of which was "A New Nation by Improved Highways," has prompted the American Road Builders' Association to offer another similar award for the coming college year. Judges in the recent contest were W. H. Connell, Harrisburg, Pa., President of the Road Builders' Association; S. S. Steinberg, Assistant Director, Highway Research Board of the National Research Council; Thos. H. MacDonald, Chief, Bureau of Public Roads, Washington; A. H. Blanchard, Dean of Engineering, University of Michigan, and C. R. Ege, President of the Highway Industries Exhibitors Association. The essay that won the first prize follows:

"A New Nation by Improved Highways."
By George F. Gerling, University of Wisconsin

"Good roads signify progress. 'All roads lead to Athens' made that center of ancient Greek civilization the greatest city of its time. The Egyptians were great road builders before they achieved the pyramids. The Romans criss-crossed their empire with good roads and became world-leaders. Napoleon's military roads helped make France a world power. Great road-building nations have been leaders in civilization.

"Stories of highway development in the United States read like romance. Sturdy frontiersmen following Indian trails or hewing paths through the wilderness were the first road builders. Intrepid pioneers blazed trails through forests and across plains for their prairie schooners. Carriages and the stage coach brought about turnpikes, toll roads, and the first public roads.

"But horse and ox-drawn traffic did not require a high type of road, and there was little appreciation of the utility and economic value of improved highways. Decades passed. Then came the motor driven vehicles.

"Suddenly brought into a roadless world, the automobile has been a most powerful missionary for the good roads movement. Rapidly changed from a luxury to a necessity by tremendous industrial development, the automobile crystallized and organized public sentiment into a crying need for good highways.

"Increasing like a rolling snowball, the good roads movement becomes nation-wide and reaches out into the most remote hamlet. Given additional impetus by the Townsend bill, road building has become the people's greatest industry.

"Speaking in terms of thousands of miles and millions of dollars, descriptive statistics fail to convey a real idea of the enormity of this industry. Clearly enough, the immense program we are engaged in, and the far-visioned plans of statesmen and engineers will directly affect the life of every man, woman and child in the United States.

"Improved highways benefit urban life by stimulating business and trade for banks, hotels, merchants, and other business men. Consumers' markets for farm produce and fresh foodstuffs are made possible. Quick communication and transportation by motor bus and motor truck develops between cities. Improved highways afford the city worker opportunity for pleasure and recreation in the country sunshine.

"Improved highways bring civilization in all its forms to farms and rural communities. Rural delivery of mail and educational opportunities in city and consolidated schools for country boys and girls are possible only through good all-weather roads. Improved highways make markets accessible for the farmer, and increase land values. Rural and social religious life is stimulated, because good roads and isolation are incompatible.

"Improved highways open up the scenic beauties of our country and the pleasures of travel. The great movement of tourists over our highways alone justifies the millions we spend. It means a broadening of the national and mental horizon—interchange of ideas. Isolated, old world communities, snug in their own traditions venture out and mingle with the rest of the United States."

A Back-Up Fresno Hitch

A new tractor hitch for Fresno scrapers that enables the operator to back up, thus doing away with the usual circling in dirt moving with scrapers has been placed on the market by the Fenton Manufacturing Co., 1243 Hathaway Ave., Lakewood, O. It is claimed also that the hitch makes it possible to back fill with the Fresno. A feature of this hitch is a specially designed universal joint so arranged that when backing over uneven ground the scraper may tip up and down or from side to side without strain on any of the parts. In fact it is stated that the Fresno has been backed up steep slopes so that the scraper has been 4 ft. above the draw bar of the tractor. The hitch is readily attached to Fordsons either with or without fenders, although a slightly different brace is used in each instance. The hitch can be used on the tractor without the Fresno scraper, a chain slot in the upper plate accommodating a chain for any kind of drawbar work, or for hauling wagons a coupling pin only is needed.

Hitch between Fresno 1-man Automatic Scraper and Fordson

New Trade Publications

The following trade publications of interest to highway officials, engineers and contractors have been issued recently. Copies of them can be obtained by addressing the firms mentioned:

Portable Air Compressors.—A bulletin devoted to its improved type of portable compressor for the Fordson has just been issued by the Curtis Pneumatic Machinery Co., 1681 Kienlen Ave., St. Louis, Mo. The various features of the outfit are illustrated and described and specifications are given. Information also is included on operation, on capacities of various tools and the cost of their operation. The above item appeared in our Feb. 3 issue with the address of the company erroneously given as Cincinnati, O.

Road Building Equipment.—A new 100 page general catalog dealing with its road construction and maintenance equipment has just been issued by the Austin-Western Road Machine Co., 400 North Michigan Blvd., Chicago, Ill. Besides containing revised specifications and descriptions and new or corrected illustrations of many of the older models, the new edition also describes several entirely new machines like the Mammoth Junior Grader, the Austin-International 10-20 and 15-30 Motor Graders, the Western Road Metal Plant and the Western Street Excavator.

Curing and Hardening Concrete Roads.—The use of silicate of soda for curing and hardening concrete roads is described in a booklet, issued by the Grasselli Chemical Co., Cleveland, O. Methods of using the product together with cost data are given, as well as results of tests of concrete cured and hardened by this system.

Separator Magnets—A circular describing the use of separator magnets for removing tramp iron in crushing operations has been issued recently by the Electric Controller & Mfg. Co., 2700 East 79th St., Cleveland, O.

Air Compressors and Concrete Breakers. Bulletins dealing with these products have been issued by the Sullivan Machining Co., 122 South Michigan Ave., Chicago, Ill. "Speed Up With Air" is the title of the road builders' and contractors' booklet, illustrating Sullivan portable air compressors, and many applications of Sullivan rotator hammer, drills, clay spaders, concrete breakers, portable hoists, etc. Tables of capacities and specifications are given. Bulletin 81-I relates to Sullivan concrete breakers, featuring two new types—DW-221 75 lb. Heavy duty buster, and 48 lb. DP-221 light buster, for concrete breaking in street opening, demolition work of many kinds, etc.

Industrial Notes

P. A. Koehring, General Manager and Secretary-Treasurer of the Koehring Co., was recently unanimously elected president of the Milwaukee Association of Commerce.

H. M. Pratt has been elected second vice-President and sales manager of the Southern Iron & Equipment Co., Atlanta, Ga. Mr. Pratt has been connected with this company for a number of years, sometime past as manager of their New Orleans office, and more recently as general sales manager. R. A. Garner succeeds A. J. Merrill, deceased, as Secretary and Treasurer of the Southern Iron & Equipment Co. Mr. Garner has been connected with this company since 1910.

"The Cutler-Hammer Mfg. Co., of Milwaukee, Wis. has opened a new sales office in the Healey Building, Atlanta,, Ga. This office will take care of the trade in the states of North Carolina, South Carolina, the eastern section of Tennessee, Georgia, Florida, Southern Alabama, and Mississippi. A. G. Gibson, formerly of the Philadelphia Office, is in charge. The General Machinery Co., of Birmingham, Ala., will continue to serve their trade in the northern half of Alabama."

Chester S. Ricker, director of advertising and consulting engineer with the Waukesha Motor Co., acted as director of timing and scoring for the first race Feb. 22, on the new board automobile speedway at Fulford, Miami, Fla. For 14 years Mr. Ricker has had charge of this department at the Indianapolis Motor Speedway, and for five years has directed all the major events of the National Power Boat Association, and National Aeronautical Association so far as the timing and scoring is concerned.

J. W. Fordney, formerly chairman of the ways and means committee of the United States Congress, and who has been closely identified with the Ruggles Motor Truck Co. for the past two years as a director, was elected president of the company at a meeting of the newly elected board held on Feb. 9th at Saginaw, Mich. Other officers elected were: First Vice-President and General Manager, R. J. Goldie, re-elected to the position he has held for three years; Second Vice-President, H. R. Wickes, of the Wickes Boiler Co. and Wickes Brothers Machine Co., who was elected to the office left vacant by the death of W. J. Wickes; Treasurer, Chas. T. Kerry, President of the Kerry & Way Lumber & Manufacturing Co. and of the Kerry & Hanson Flooring Co., re-elected to the office he has held since the inception of the company; Mr. E. L. Smith, re-elected Secretary, who has also held this office since the company's inception; Mr. R. L. Anderson, re-elected Assistant Treasurer; and Mr. A. I. Hawkins, elected Assistant Secretary. The Ruggles Motor Truck Co. has enjoyed a prosperous business during the past year with greatly increased production and reports very favorable prospects, both foreign and domestic, for the ensuing year.

The American Hoist & Derrick Co., which has its works and main offices at Saint Paul, Minn., has recently opened another branch office, at 1943 Railway Exchange Bldg., St. Louis, Mo., with Ward B. Maurer in charge. Before joining the sales force of the American Hoist & Derrick Co., several yars ago, Mr. Maurer was a member of the engineering staff of the Baltimore & Ohio R. R.

Meetings and Conventions

Heating & Ventilating Exposition.—Exposition, Madison Square Garden, New York City, March 17-23. E. P. Frenz, Secy., Hotel McAlpin, New York City.

Concrete Reinforcing Steel Institute.—Annual meeting, March 10 and 11, at Hotel Traymore, Atlantic City, N. J. M. A. Beeman, secretary, 160 N. La Salle St., Chicago, Ill.

Indiana Section, American Water Works Association.—March 25 and 26, at Purdue University, Lafayette, Indiana. C. K. Calvert, secretary, 1902 N. New Jersey Ave., Indianapolis, Ind.

Montana Section, American Water Works Association.—April 15-17, at Butte, Montana. Herbert B. Foote, secretary, State Board of Health, Helena, Mont.

American Water Works Association.—Annual meeting, Buffalo, N. Y., June 7-11. Secretary, Beekman C. Little, City Hall, Rochester, N. Y.

American Society for Testing Materials.—Convention Haddon Hall, Atlantic City, N. J., June 21-25. C. L. Warwick, Secy., 1315 Spruce St., Philadelphia, Pa.

American Society of Mechanical Engineers.—Spring convention, San Francisco, Calif., June 28-30. Calvin W. Rice, Secy., 29 West 39th St., New York City.

Motion Pictures of Asphalt Paving Work.—Two motion pictures, one dealing with the method of constructing a sheet asphalt pavement and the other with the method of constructing asphalt macadam have been made by the Texas Co. The asphalt macadam film consists of one reel which can be shown in 15 to 20 minutes. The other consists of two reels and requires from 30 to 40 minutes to show. Both give a clear and comprehensive idea of the types of paving work treated. The films will be loaned to organizations, clubs or educational institutions. Inquiries for this purpose should be addressed to The Texas Co., Asphalt Sales Department, 17 Battery Pl., New York City. The letter should mention several dates on which the use of either or both of the films is desired.